AGRICULTURAL BALE ACCUMULATOR AND METHOD THEREFOR

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of International Application Number PCT/US97/15574, entitled "Agricultural Bale Accumulator Having A Load Bed Extension Module," filed under the Patent Cooperation Treaty on September 2, 1997 by Phillip G. Spaniol, Stephen J. Spaniol and Kevin D. Kaschke and assigned to Farm Technology, L.L.C..

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to agricultural machinery and methods therefor for harvesting crop material such as hay, straw, grass and the like, and, more particularly, relates to an agricultural bale accumulator and method therefor.

2. Description of the Prior Art

A continuing trend to achieve an efficient farming operation and to decrease manual labor provides the need for efficient and capable agricultural machinery. One type of agricultural machinery is used to harvest crop material such as hay, straw, grass and the like.

An agricultural baler ("baler") is a widely used piece of mobile equipment which collects and compresses the crop material as it travels over the ground to produce a compact unit of crop, commonly referred to as a bale. The baler may comprise a motorized machine driven by an operator or, alternatively, may comprise a wheeled frame adapted for traveling alongside or behind a tractor. Typically, a baler is a wheeled chassis adapted for hitched connection to a tractor to be towed in tandem behind the tractor. After the baler forms a bale, a cord, such as wire or twine, is tied around the bale to hold the bale together in its compressed form. The baler ejects the tied bales periodically from a bale chamber of a baler as the baler travels over the ground. Each ejected bale may be directly discharged either to a bale accumulator or to the ground for later pick up by a bale collector in order to make the harvesting of the crop material more efficient and to decrease manual labor. Bales provided by either the bale accumulator or the bale collector may then be deposited on a vehicle, such as a tractor trailer, for hauling to another location for storage.

A bale accumulator is a widely used piece of mobile equipment which may comprise a part of a baler or, alternatively, may comprise a wheeled chassis adapted for traveling alongside or behind a baler. Typically, a bale accumulator is a wheeled chassis adapted for hitched connection to a baler to be towed in tandem behind the baler. Examples of conventional bale accumulators are disclosed in U.S. Patent Nos. 3,272,352, 4,310,275, 4,215,964 and 4,961,679. A bale accumulator is normally arranged to receive a plurality of successive bales as they eject from the bale chamber of the baler and to accumulate the received bales into a group or parcel of

accumulated bales for temporary storage. The group of accumulated bales may then be discharged onto the ground in an ordered array permitting mechanical recovery thereof or, otherwise, be mechanically removed from the bale accumulator.

A bale collector is a widely used piece of mobile equipment which may comprise a motorized machine driven by an operator or, alternatively, may comprise a wheeled chassis adapted for traveling alongside or behind a tractor. Typically, a bale collector is a motorized machine driven by an operator. The bale collector is normally arranged to pick up individual bales from the ground and to accumulate the retrieved bales into a group or parcel of collected for temporary storage. The group of collected bales may then be discharged onto the ground in an ordered array permitting mechanical recovery thereof or, otherwise, be mechanically removed from the bale collector.

Since the phrases "bale accumulator" and "bale collector" are sometimes referred to interchangeably in the agricultural industry, the present invention generally refers to both pieces of equipment as a bale accumulator in the sense that both pieces of equipment receive and store bales. Therefore, it is contemplated that the present invention may be used on a bale collector as well as the bale accumulator, as described hereinabove.

Bales vary in size and shape according to the type of baler used to form the bales. The types of balers generally include rectangular balers and round balers. Some rectangular balers form so-called small-sized bales measuring about 36 cm x 46 cm x 31 cm to 132 cm and weighing 18 kg to 27 kg. Other rectangular balers form so-called medium-sized bales measuring about 80 cm x 87 cm x up to 249 cm and weighing 300 to 600 kg. An example of a rectangular baler forming medium-sized bales is disclosed in U.S. Patent No. 4,525,991. Still other rectangular balers form so-called large-sized bales measuring about 118 cm x 127 x up to 274 cm and weighing up to 1000 kg. Examples of rectangular balers forming large-sized bales are disclosed in U.S. Patent Nos. 4,034,543 and 4,307,528. Some round balers form so-called cylindrical-sized bales measuring about 1.75 m in diameter x 1.75 m long and weighing 450 kg to 675 kg.

The bale accumulator of the present invention is particularly well-suited for use in conjunction with rectangular balers producing the medium-sized bales. However, it will be apparent from the description and claims which follow that the principles of the present invention are not limited to bale accumulators for rectangular balers producing medium-sized bales. The present invention may be utilized with great effectiveness in conjunction with rectangular balers producing the large-sized bales, rectangular balers producing the small-sized bales as well as round balers producing the cylindrical-sized bales.

U.S. Patent Nos. 4,961,679 and 4,955,774 each disclose an agricultural bale accumulator having a bale-transfer and bale-turning mechanism attached to one side of a chassis and an extension table pivotally attached to an opposite side of the chassis. The extension table is moveable between a horizontal bale accumulating position and a vertical transport position. The extension table and a main bale-receiving table, supported by the chassis, form a load bed for accumulating thereon up to four medium sized bales. The extension table can accommodate one bale when located in the horizontal operative position. When the extension table is attached to the

chassis, an additional castor wheel is provided on a main axle supporting the chassis in order to accommodate the extra load that can be accumulated on the extension table. Bales received on one side of the load bed are turned 90 degrees and transferred across the load bed. The bales are discharged using a bale-discharge conveyor which pushes the bales accumulated on the load bed off the load bed to the ground.

However, U.S. Patent Nos. 4,961,679 and 4,955,774 do not disclose a support system which contacts the extension table at a location beyond a side of a chassis to which the extension table is attached. Therefore, the extension table does not have any direct support for a bale accumulated thereon from either the chassis or the ground. A lack of direct support for the extension table places all the stress due to the weight of a bale on the hinge which may weaken or break over time under normally rigorous field conditions. These patents also do not disclose attaching the extension table to the main bale-receiving table. These patents also do not disclose a bale discharge module for moving the main bale-receiving table between a bale accumulating position and bale discharging position, wherein the main bale-receiving table is in a horizontal position and an inclined position, respectively, relative to the chassis. Therefore, these patents do not teach or suggest a need for supporting an extension table, at a location beyond a side of the load bed to which the extension table is attached, when the extension table is in the unstowed position and when the load bed is in a bale accumulating position and/or a bale discharging position relative to a main frame.

U.S. Patent No. 4,844,675 discloses an agricultural bale accumulator having a center table, a right table and a left table. The center table receives large-sized bales from a bale chamber of a baler. A push bar pushes a bale on the center table to the right or left table. The right and left tables are provided with associated extensions which appear to have a width dimension approximately equal to one third a width dimension of each of the right and left tables. A hinge connects each extension to its associated table so that it may be moved between a transport and storage position on a top surface of its associated table and an unfolded position coplanar with its associated table. When an extension is in its transport and storage position, a sensor is actuated to give a false indication that a bale in on its associated table. The sensor provides a control signal to the push bar to prevent movement of the push bar toward that table thereby preventing damage to the push bar that would result if a bale were moved onto a table whose extension is folded to the transport and storage position. The right and left tables are pivotally mounted on their frames between a bale accumulating position and a bale discharging position so that when the tables are unlatched they tilt downwardly at the rear of the tables under the weight of the bale to permit a bale carried thereon to slide to the ground as the bale accumulator continues its forward movement. When the weight of the bale is removed from a table a spring pulls the table back to its latched position.

However, U.S. Patent No. 4,844,675 does not disclose a purpose for the extensions when unfolded to a position coplanar with the associated tables. Since the extensions appear to have a width dimension approximately equal to one third a width dimension of each of the right and left tables, it is clear that each of the extensions cannot accumulate an additional large bale.

This patent also does not disclose a support system which contacts the extension at a location beyond the side of the table to which the extension is attached. Therefore, the extension does not have any direct support for a partial bale which may be accumulated thereon from either a main frame or the ground. A lack of direct support for the extension places all the stress due to the weight of a partial bale on the hinge which may weaken or break over time under normally rigorous field conditions. Further, this patent does not teach or suggest a need for supporting the extension, at a location beyond the side of the table to which the extension is attached, when the extension is in the unstowed position and when the table is in the bale accumulating position and/or the bale discharging position.

Hoelscher, Inc., located at 312 S. Main, P.O Box 195, Bushton, Kansas, U.S.A., 67427, manufactures a bale accumulator Model 1030 having a load bed pivotally mounted to a main frame. The load bed includes a center table and two side tables on opposite sides of the center table. The bale accumulator bale has a carrying capacity of three total bales on each of the three tables and a bale dumping capacity of two of the three total bales from the two side tables. The center table continuously receives bales from a bale chamber of a baler during while baling and is not permitted to dump any bales. The two side tables dump the two bales by pivoting about a pivot axis between a bale accumulating position and a bale discharging position, wherein the two side tables are in a horizontal position and an inclined position, respectively, relative to the main frame.

However, Holescher's bale accumulator Model 1030 is limited to a bale accumulation capacity of three bales and to a bale discharge capacity of two bales. Holescher's bale accumulator does not have an extension table connected to a load bed and moveable relative to the load bed between a stowed position and an unstowed position, wherein the extension table is substantially co-planar with the load bed and adjacent to the side of the load bed when the extension table is in the unstowed position to permit the extension table to accumulate thereon an additional bale. Therefore, Holescher's bale accumulator Model 1030 cannot accumulate more than three bales.

Recently, Case IH Corporation, located at 700 State Street, Racine, Wisconsin, Illinois, 53404, U.S.A., introduced a bale accumulator Model 8576 having a load bed pivotally mounted to a main frame. The load bed includes a center table and two side tables on opposite sides of the center table. The two side tables each have an extension table pivotally attached a longitudinal side thereof and moveable between a stowed, road transport position and an unstowed, bale accumulating position The bale accumulator Model 8576 has a bale has a carrying capacity of five total bales on each of the three tables and the two extension tables and a bale dumping capacity of four of the five total bales from the two side tables and the two extension tables. The center table continuously receives bales from a bale chamber of a baler during while baling and is not permitted to dump any bales. The two side tables and the two extension tables dump the two bales by pivoting, about a pivot axis mounted on the main frame, from a bale accumulating position to a bale discharging position, wherein the two side tables are in a horizontal position and an inclined position, respectively, relative to the main frame.

However, Case IH Corporation's bale accumulator Model 8576 does not disclose a support system which contacts the extension table, at a location beyond the side of the load bed to which the extension table is attached, when the extension table is in the unstowed position and when the load bed is in the bale accumulating position and/or the bale discharging position. Therefore, the extension table does not have any direct support for a bale which may be accumulated thereon from either a main frame or the ground. A lack of direct support for the extension table places all the stress due to the weight of a bale on a hinge which may weaken or break over time under normally rigorous field conditions.

U.S. Patent Nos. 4,961,679, 4,955,774 and 4,844,675 and Case IH Corporation's bale accumulator Model 8576 each teach only one extension table pivotally attached to one side of the chassis, load bed and load bed, respectively. These references do not teach or suggest attaching additional extension tables to the one extension table or supporting the one extension table in combination with any additional extension tables. Further, each of these references only teach a hinged connection between the extension table and the load bed.

Various bale stacking mechanisms for accumulators are known as provided in the following disclosures. U.S. Patents 4,363,583 and 4,952,111 disclose a mechanical arm that picks up and move over to the accumulator's load bed to form a stack of bales. This type of stacking mechanism is disadvantageous because the mechanical arms are large and complicated. U.S. Patents 3,446,369, 3,414,139, 3,487,955, 3,918,595, 5,405,229 and 4,203,695 each disclose a bale stacking mechanism implemented as a separate loading table pivotally connected to a side of the accumulator's load bed between a horizontal bale receiving position for receiving bales a horizontal plane and a vertical bale delivery position for delivering the horizontally received bales in a vertical stacked arrangement on the load bed. This type of stacking mechanism is disadvantageous because the separate loading table is offset from the bale chute of the baler takes up extra space and cannot accumulate bales for discharging. U.S. Patents Re 25,750, 3,278,049, and 3,251,485 each disclose a bale stacking mechanism implemented as a separate loading platform located in front of the accumulator's load bed where stacks of bales are formed prior to being moved onto the accumulator's main load bed which accumulates and discharges the bales. This type of stacking mechanism is disadvantageous because the platform performs a dedicated stacking task and cannot accumulate bales for discharging. U.S. Patent 4,370,796 discloses a bale stacking mechanism implemented as a by receiving a row of bales across a lateral axis of the accumulator's load bed, then lifting the first row, then receiving a second row of bales below the first row, then stacking the first and second rows before pushing the stack across a longitudinal axis of the load bed. This type of stacking mechanism is disadvantageous because the mechanism receives the bales along the lateral axis of the load bed. Claas of America, Inc., having an address at 3030 Norcross Drive, Box 3008, Columbus, Indiana 47202-3008 produces an accumulator called the Quadrant 1100 which forms a stack of two bales by dropping a first bale below a bale receiving position, then receiving a second bale on top of the first bale and then discharges the only two bales to the ground by dropping the bottom out from under the first bale received. This

type of stacking mechanism is disadvantageous because accumulator can only accumulate two bales in a stack and only two bale for the entire accumulator.

The following two patent disclose a type of control for the accumulator. U.S. Patent No. 4,312,245 discloses a bale accumulator having a center, a right and a left table. A push bar pushes a bale on the center table to the right or left table. Each table has an associated switch which senses the position of a bale on that table. By monitoring the switches, the bale accumulator automatically forms a load on the tables yet permits the operator to be the sole judge of when the accumulated load of bales is to be dumped. However, the accumulator always forms the same arranged load on the accumulator. U.S. Patent No. 4,844,675 discloses a bale accumulator having a center, a right and a left table. A push bar pushes a bale on the center table to the right or left table. A microprocessor-based control circuit determines a status of the position of the bales on the tables and displays the status on an operator's panel. The control circuit monitors bale switches actuated by the presence of bales on the tables, two switches indicating the position of the push bar, and three table switches indicating when individual one of three of the bales are latched or released for dumping bales therefrom. An operator's panel provides a visual display of the status of the bale accumulator and includes switches which may be actuated by the operator. In response to the switches on the accumulator, the control circuit controls the push bar to move bales from the center table onto the left or right table at the sides of the center table, or inhibits movement of the push bar so that a succeeding bale ejected from the baler pushes a bale on the center table onto a trailing fourth table. In response to actuation of a dump switch, the control circuit determines which tables should be unlatched to dump a bale therefrom, and energizes a motor or motors to unlatch the tables as determined by the control circuit. Although this accumulator has some automatic features, the operator is required to actuate the dump switches.

The following disclosures are related to the discharge of bales from the accumulator.

Two mechanisms are generally used to discharge bales from a load bed of a bale accumulator. One mechanism employs a load bed pivotable relative to a chassis of the bale accumulator. When the load bed assumes an inclined position the bales slide off the end of bale accumulator to the ground under the force of gravity as the bale accumulator advances. The load bed may assume the inclined position either by exerting a force on the load bed or by permitting the weight of the bales to pivot the load bed.

Another mechanism is a discharge conveyor arrangement provided on the floor of a fixed load bed and operable to push bales in a rearward direction off the end of the bale accumulator. However, this causes multiple problems such as a required adjustment of conveyor discharge speed with the ground speed of the bale accumulator to permit bales to be discharged in an ordered array in side-by-side adjacent relationship for recovery by a mechanized loader. Thus, the bales may be scatterd or disoriented upon discharge. Also a complex and costly chain and drive mechanism tends to accumulate litter requiring careful maintenance, and necessitating significant driving energy is required.

The accumulation of big bales provides certain problems because of the size and considerable weight of the bales. Whereas the accumulation of orignal small rectangular bales enabled the bales to be "dropped" from the baler onto a receiving station of the accumulator, the size and weight of big bales does not permit such delivery methods.

Another problem with the collating of big bales is that they are delivered continuously from the baler. One bale is juxtaposed to the next and careless separation of a bale which has just been formed from one that is still being formed in the baler can cause damage, not only to the bale but may affect operation of the baler itself.

U.S. Patent 4,312,245 discloses a bale accumulator having a chassis and a bale receiving bed comprising a central part and two side parts. A bale is received from the baler on the central part and may be moved to either one side part of the other side part. The two side parts are moveable to a bale delivering position to deliver the bales stored thereon to the ground. Although the bale accumulator is large enough to support three bales, it cannot deliver an array of three bales to the ground since the central part has to remain fixed to receive bales from the baler.

U.S. Patent No. 4,215,964 shows a bale accumulator for use in conjunction with a so-called large rectangular baler having a generally centrally disposed bale case as seen in traverse direction of the machine. The bale accumulator, in operation, is coupled to the rear of the baler with a central bale receiving table generally aligned with the bale case and with bale holding platforms at both sides of the bale receiving table. Bale transfer means are associated with the receiving table and are operable successively to transfer one bale from the receiving table to one bale from the receiving table to one side platform and a next bale from the receing table to the opposite side platform. These side platforms are pivotable to dump the pair of baled collected thereon onto the ground while that a third bale inches its way onto the centrally disposed bale receiving table. However, this arrangement cannot group several bales side-by-side and dump such bales as an accumulated unit on the ground in a suitable position for later to be picked up as such by a clamp apparatus.

European Patent Specification 0 288 322 B1 discloses a bale accumulator having a bale receiving bed mounted on a chassis. The bales received from the baler may be moved on different areas of the bed. The bed has a first entry part and a second moveable part. The second moveable part is moveable from a bale receiving position to a bale delivery position. The first entry part and the second moveable part are relatively arranged such that the last bale of the array of bales to be formed by the accumulator is positioned such that it overlies part of the second moveable part. The second moveable part is moved from its bale receiving position to its bale delivery position in a direction so as to cause movement of the last bale away from the next bale to be delivered onto the bale receiving bed.

Accordingly, there is a need for an agricultural bale accumulator with a large bale accumulating capacity and intelligent bale accumulation and bale discharge operations to permit efficient, flexible and desirable harvesting of hay and forage without the disadvantages of the prior art described hereinabove.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGs. 1 and 2 illustrate, in a top, rear and right side perspective view, an agricultural bale accumulator having a first embodiment of a load bed extension module including a first extension table and a second extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of the load bed being located in a bale accumulating position.

FIGs. 3 and 4 illustrate, in a top and right side perspective view and a top and right side perspective view, respectively, the agricultural bale accumulator of FIG. 1 having the first embodiment of the load bed extension module including the first extension table and the second extension table each being located in the unstowed position and the bale accumulating portion of the load bed being located in a bale discharging position.

FIG. 5 illustrates, in a top, front and right side perspective view, the agricultural bale accumulator of FIG. 1 having the first embodiment of the load bed extension module including the first extension table and the second extension table each being located in the unstowed position and the bale accumulating portion of the load bed being located in the bale accumulating position.

FIG. 6 illustrates, in a top, front and right side perspective view, a magnified view of an area of FIG. 5 primarily showing an extension table support mechanism of the first embodiment of the load bed extension module for the first extension table when the first extension table is located in the unstowed position and the bale accumulating portion of the load bed is located in the bale accumulating position and primarily showing a load bed alignment mechanism for a right side of the bale accumulating portion of the load bed when the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 7 illustrates, in a top, front, and left side perspective view, the agricultural bale accumulator of FIG. 2.

FIG. 8 illustrates, in a top, front, and left side perspective view, a magnified view of an area of FIG. 7 primarily showing an extension table support mechanism of the first embodiment of the load bed extension module for the second extension table near a pivot point between the bale accumulating portion of the load bed and a main frame when the second extension table is located in the stowed position and the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 9 illustrates, in a bottom, rear and right side perspective view, a magnified view of an area of FIG. 1 primarily showing the extension table support mechanism for the first extension table near the pivot point between the bale accumulating portion of the load bed and the main frame when the first extension table is located in the unstowed position and the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 10 illustrates, in a bottom, front and right side perspective view, a magnified view of an area of FIGs. 3 and 4 primarily showing the extension table support mechanism for the first extension table near the pivot point between the bale accumulating portion of the load bed and the

main frame when the first extension table is located in the unstowed position and the bale accumulating portion of the load bed is located in the bale discharging position.

FIGs. 11 and 12 illustrate, in a top and rear side perspective view, an agricultural bale accumulator having a second embodiment of a load bed extension module including a first extension table and a second extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of the load bed being located in a bale accumulating position.

FIGs. 13 and 14 illustrate, in a top and right side perspective view and a top and rear side perspective view, respectively, the agricultural bale accumulator of FIG. 11 having the second embodiment of the load bed extension module including the first extension table and the second extension table each being located in the unstowed position and the bale accumulating portion of the load bed being located in a bale discharging position.

FIG. 15 illustrates, in a top, front and right side perspective view, the agricultural bale accumulator of FIGs. 13 and 14 primarily showing an extension table support system of the second embodiment of the load bed extension module for the first extension table.

FIG. 16 illustrates, in a top, front and right side perspective view, a magnified view of an area of FIG. 15 primarily showing a closer view of the extension table support system of the second embodiment of the load bed extension module for the first extension table.

FIG. 17 illustrates, in a top, front and right side perspective view, a magnified view of an area of FIG. 16 primarily showing a still closer view of the extension table support system of the second embodiment of the load bed extension module for the first extension table.

FIG. 18 illustrates, in a top, rear and left side perspective view, a magnified view of an area of FIGs. 15 and 16 primarily showing a load bed latch mechanism attached to a main frame under a right side of the bale accumulating portion of the load bed.

FIG. 19 illustrates, in a top, front and right side perspective view, the agricultural bale accumulator of FIG. 12 having the second embodiment of the load bed extension module including the first extension table and the second extension table each being located in the stowed position and the bale accumulating portion of the load bed being located in the bale accumulating position.

FIG. 20 illustrates, in a top, rear and right side perspective view, a magnified view of an area of the agricultural bale accumulator of FIGs. 12 and 19 primarily showing an extension table support system of the second embodiment of the load bed extension module for the first extension table when the first extension table is located in a position between the stowed position and the unstowed position and when the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 21 illustrates, in a top, rear and right side perspective view, a magnified view of an area of FIGs. 12. 19 and 20 primarily showing a still closer view of the extension table support system of the second embodiment of the load bed extension module for the first extension table when the first extension table is located in the stowed position and when the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 22 illustrates, in a bottom, front and right side perspective view, a magnified view of an area of FIG. 11 showing the extension table support system of the second embodiment of the load bed extension module for the first extension table when the first extension table is located in the unstowed position and when the bale accumulating portion of the load bed is located in the bale accumulating position.

FIG. 23 illustrates, in a bottom, rear and right side perspective view, a magnified view of an area of FIGs. 11 and 22 primarily showing the extension table support system of the second embodiment of the load bed extension module for the first extension table when the first extension table is located in the unstowed position and when the bale accumulating portion of the load bed is located in the bale accumulating position.

FIGs. 24 and 25 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a third embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 26 and 27 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a fourth embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 28 and 29 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a fifth embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 30 and 31 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a sixth embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 32 and 33 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a seventh embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 34 and 35 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a eighth embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 36 and 37 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having an ninth embodiment of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position, respectively, and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIGs. 38, 39 and 40 illustrate, in a rear side elevation view, a right side of an agricultural bale accumulator having a tenth, eleventh and twelfth embodiment, respectively, of a load bed extension module including a first extension table and a third extension table each being located in an unstowed position and a stowed position and a bale accumulating portion of a load bed being located in a bale accumulating position.

FIG. 41 illustrates a schematic diagram of a hydraulic system for use with the agricultural bale accumulator of FIGs. 1 - 40.

FIG. 42 illustrates a table having thirty six embodiments of an extension table support system for a load bed extension module for use on and/or off a pivot axis, permitting a bale accumulating portion of a load bed to pivot relative to a main frame, and for use with one or more extension tables.

FIG. 43 illustrates a flowchart describing a first general bale stacking method for forming and accumulating stacks of bales on a load bed of an agricultural bale accumulator and for discharging the stacks of bales to a ground surface.

FIG. 44 illustrates a flowchart describing a first particular bale stacking method for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by raising the bales above the load bed to form a stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

FIG. 45 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the first particular bale stacking method described in FIG. 44 to accumulate the stacks of bales on the load bed.

FIG. 46 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to an alternate embodiment of the first particular bale stacking method described in FIG. 44 to accumulate the stacks of bales on the load bed by transferring the bales across the load bed then raising the bales above the load bed to form the stack of bales.

FIG. 47 illustrates, in a right side elevation view, an agricultural bale accumulator having a first embodiment of a bale stacking apparatus for raising the bales above a load bed responsive to the first particular bale stacking method described in FIG. 44 and the sequence of bale handling operations shown in FIG. 45.

FIG. 48 illustrates, in a top side plan view, the agricultural bale accumulator having the first embodiment of the bale stacking apparatus shown in FIG. 47.

FIG. 49 illustrates, in a rear side elevation view, the agricultural bale accumulator having the first embodiment of the bale stacking apparatus shown in FIGs. 47 and 48.

FIG. 50 illustrates, in a rear side elevation view, an agricultural bale accumulator having a second embodiment of a bale stacking apparatus for raising bales above the load bed responsive to the first particular bale stacking method described in FIGs. 44 and the sequence of bale handling operations shown in FIG. 45.

FIG. 51 illustrates, in a top side plan view, the agricultural bale accumulator having the second embodiment of the bale stacking apparatus shown in FIG. 52.

FIG. 52 illustrates a flowchart describing a second particular bale stacking method for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by lowering the bales below the load bed to form a stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

FIG. 53 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the second particular bale stacking method described in FIG. 52 to accumulate the stacks of bales on the load bed.

FIG. 54 illustrates, in a rear side elevation view, an agricultural bale accumulator having a third embodiment of a bale stacking apparatus for lowering the bales below a load bed responsive to the second particular bale stacking method described in FIG. 52 and the sequence of bale handling operations shown in FIG. 53, wherein a bale receiving portion of the load bed is located in a bale lowering position.

FIG. 55 illustrates, in a rear side elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking apparatus shown in FIG. 54, wherein the bale receiving portion of the load bed is located in a bale receiving position.

FIG. 56 illustrates, in a right side elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking apparatus shown in FIGs. 54 and 55, wherein the bale receiving portion of the load bed is located in the bale receiving position.

FIG. 57 illustrates, in a right side elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking apparatus shown in FIGs. 54 ,55 and 56, wherein the bale receiving portion of the load bed is located in the bale lowering position.

FIG. 58 illustrates, in a top side plan view, the agricultural bale accumulator having the third embodiment of a bale stacking apparatus shown in FIGs. 54 ,55, 56 and 57, wherein the bale receiving portion of the load bed is located in the bale receiving position.

FIG. 59 illustrates a flowchart describing a third particular bale stacking method for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by raising and/or lowering the bales above and/or below the load bed, respectively, to form the stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

FIG. 60 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the third particular bale stacking method described in FIG. 59 and using the second embodiment of a bale stacking apparatus shown in FIGs. 50 and 51 in combination with the third embodiment of a bale stacking apparatus

shown in FIGs. 54-58 to accumulate the stacks of bales on the load bed, wherein a first received bale is raised above the load bed and a second received bale is lowered below the load bed.

FIG. 61 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the third particular bale stacking method described in FIG. 59 and using the second embodiment of a bale stacking apparatus shown in FIGs. 50 and 51 in combination with the third embodiment of a bale stacking apparatus shown in FIGs. 54-58 to accumulate the stacks of bales on the load bed, wherein a first received bale is lowered below the load bed and a second received bale is raised above the load bed.

FIG. 62 illustrates a flowchart describing a second general bale stacking method for accumulating bales on a plurality of load beds of an agricultural bale accumulator which are disposed parallel to and vertically displaced relative to each other along a common vertical load bed axis and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

FIG. 63 illustrates a flowchart describing a first particular bale stacking method for performing the second general bale stacking method described in FIG. 62 for accumulating the bales on the plurality of load beds, by accumulating the bales on a first load bed, moving the first load bed above a second load bed, then accumulating the bales on the second load bed, and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

FIG. 64 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the first particular bale stacking method described in FIG. 63 to accumulate the bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

FIGs. 65 and 66 illustrate, in a rear side elevation view and a top side plan view, respectively, an agricultural bale accumulator having a first embodiment of the bale stacking apparatus for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales responsive to the first particular bale stacking method described in FIG. 63 and the sequence of bale handling operations shown in FIG. 64.

FIGs. 67 and 68 illustrate, in a rear side elevation view and a top side plan view, respectively, an agricultural bale accumulator having a second embodiment of the bale stacking apparatus for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales responsive to the first particular bale stacking method described in FIG. 63 and the sequence of bale handling operations shown in FIG. 64.

FIG. 69 illustrates a flowchart describing a second particular bale stacking method for performing the second general bale stacking method described in FIG. 62 for accumulating the bales on the plurality of load beds, by accumulating the bales on a first load bed and a second load

bed located at a fixed position above the first load bed, and for discharging the accumulated bales to a ground surface to form stacks of bales.

FIG. 70 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations responsive to the second particular bale stacking method described in FIG. 69 to accumulate the bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales.

FIG. 71 illustrates, in a rear side elevation view, an agricultural bale accumulator having an embodiment of the bale stacking apparatus for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales responsive to the second particular bale stacking method described in FIG. 69 and the sequence of bale handling operations shown in FIG. 70, wherein a bale receiving portion of the load bed is in a bale receiving position.

FIG. 72 illustrates, in a rear side elevation view, the agricultural bale accumulator having the embodiment of the bale stacking apparatus shown in FIG. 71, wherein the bale receiving portion of the load bed is in a bale elevating position.

FIG. 73 illustrates, in a top side plan view, the agricultural bale accumulator having the embodiment of the bale stacking apparatus shown in FIGs. 71 and 72, wherein a bale receiving portion of the load bed is in a bale receiving position.

FIG. 74 illustrates a flowchart describing a bale advancement method for advancing bales on a load bed of an agricultural bale accumulator.

FIGs. 75, 76 and 77 illustrate, each in a right side elevation view, an agricultural bale accumulator having a first embodiment of a bale advancement apparatus performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74.

FIGs. 78, 79 and 80 illustrate, each in a right side elevation view, an agricultural bale accumulator having a second embodiment of a bale advancement apparatus performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74.

FIG. 81 illustrates a flowchart describing a bale arrangement control method for accumulating bales on a load bed of an agricultural bale accumulator by varying a bale accumulation arrangement responsive to an input condition.

FIG. 82 illustrates, in a rear side elevation view, an agricultural bale accumulator having a load bed extension module, including four extension tables, having a bale stacking apparatus and having a bale arrangement control module for controlling the bale accumulation arrangement responsive to the bale arrangement control method described in FIG. 81.

FIG. 83 illustrates a Table showing a plurality of bale arrangements capable of being produced by the bale arrangement control module responsive to the bale arrangement control method described in FIG. 81 for to the agricultural bale accumulator shown in FIG. 82.

FIG. 84 illustrates a flowchart describing a general stabilization method for stabilizing bales accumulated on a load bed of an agricultural bale accumulator.

FIG. 85 illustrates a flowchart describing a first particular stabilization method for performing the general stabilization method described in FIG. 84 for stabilizing bales accumulated

on a load bed, by leveling the load bed along one of a longitudinal axis and a lateral axis of the load bed.

FIG. 86 illustrates, in a right side elevation view, an agricultural bale accumulator traveling over a ground surface which varies relative to a horizontal plane, wherein a longitudinal load bed leveling apparatus levels the load bed responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface to stabilize the bales on the load bed along the longitudinal axis.

FIG. 87 illustrates, in a rear side elevation view, an agricultural bale accumulator traveling over a ground surface which varies relative to a horizontal plane, wherein a lateral load bed leveling apparatus levels the load bed responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed along the lateral axis.

FIGs. 88 and 89 illustrate, each in a rear side elevation view, the agricultural bale accumulator shown in FIG. 86 having a lateral load bed leveling apparatus for leveling the load bed along the lateral axis responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed.

FIGs. 90 and 91 illustrate, each in a right side elevation view, the agricultural bale accumulator shown in FIG. 87 having a longitudinal load bed leveling apparatus for leveling the load bed along the longitudinal axis responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed.

FIG. 92 illustrates a flowchart describing a second particular stabilization method for performing the general stabilization method described in FIG. 84 for stabilizing bales accumulated on a load bed, by adaptively moving the load bed extension tables between a stowed position and an unstowed position to stabilize the bales along the lateral axis of the load bed and to accumulate the bales on the load bed extension tables, respectively.

FIG. 93 illustrates, in a rear side elevation view, an agricultural bale accumulator having a lateral bale stabilization apparatus for performing a sequence of bale stabilizing and accumulating operations responsive to the second particular stabilization method described in FIG. 92.

FIGs. 94, 95 and 96 illustrate, each in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization apparatus for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein the lateral bale stabilization apparatus has a moveable support arm.

FIG. 97 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization apparatus for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein a bale receiving surface of each of a right bale accumulating portion of the load bed extension tables is disposed at progressively decreasing

angles, each being somewhat less than 180°, relative to a center bale receiving portion of the load bed to progressively bias the bales accumulated thereon towards the center bale receiving portion of the load bed in proportion to an increasing distance of the accumulated bales from the center bale receiving portion of the load bed.

FIG. 98 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization apparatus for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein a bale receiving surface of each of a right bale accumulating portion of the load bed extension tables is disposed at a constant angle somewhat less than 180° relative to a center bale receiving portion of the load bed to constantly bias the bales thereon towards the center bale receiving portion of the load bed over a distance between the center bale receiving portion of the load bed and the farthest positioned load bed extension table.

FIG. 99 illustrates a flowchart describing a general counterweight method for performing a part of the second particular stabilization method described in FIG. 92 to dynamically move a load bed extension table between a stowed position and an unstowed position responsive to a weight of a bale on the load bed adjacent to the load bed extension table.

FIG. 100 illustrates a flowchart describing a particular counterweight method for performing for performing the general counterweight method described in FIG. 99.

FIGs. 101 and 102 illustrate, each in a rear side elevation view, the right side of the agricultural bale accumulator shown in FIGs. 93-98, but with only one load bed extension table, showing the theory underlying the particular and general counterweight methods described in FIGs. 99 and 100, respectively.

FIG. 103 illustrates, in a rear side elevation view, the right side of the agricultural bale accumulator shown in FIGs. 93-98, but with only one load bed extension table, having a counterweight mechanism for implementing the counterweight theory described in FIGs. 101 and 102 and for performing the particular and general counterweight methods described in FIGs. 99 and 100, respectively.

FIG. 104 illustrates a flowchart describing a permissive bale discharge method for permitting a bale received on a bale receiving portion of a load bed of an agricultural bale accumulator at a first rate of speed along a bale receiving axis in a bale receiving direction to be discharged from the bale receiving portion of a load bed to a ground surface in a bale discharging direction, essentially the same as the bale receiving direction, without interfering with a successively formed bale approaching the bale receiving portion of a load bed during the bale discharge operation.

FIGs. 105 and 106 illustrate, in a right side elevation view and a top side plan view, respectively an agricultural bale accumulator having a first embodiment of a permissive bale discharge apparatus, formed by a hinged bale support member located in a load bed notch, operating responsive to the permissive bale discharge method described in FIG. 104.

FIG. 107 illustrates, in a right side elevation view, an agricultural bale accumulator having a fifth embodiment of a permissive bale discharge apparatus, formed by a pivoting load bed with a

load bed notch, operating responsive to the permissive bale discharge method described in FIG. 104.

FIG. 108 illustrates, in a right side elevation view, an agricultural bale accumulator having a second embodiment of a permissive bale discharge apparatus, formed by a sliding bale support member located in a load bed notch, operating responsive to the permissive bale discharge method described in FIG. 104.

FIG. 109 illustrates, in a right side elevation view, an agricultural bale accumulator having a third embodiment of a permissive bale discharge apparatus, formed by a rotating bale support member located in a load bed notch, operating responsive to the permissive bale discharge method described in FIG. 104.

FIGs. 110 and 111 illustrate, in a right side elevation view and a top, rear and right side perspective view, respectively, an agricultural bale accumulator having a fourth embodiment of a permissive bale discharge apparatus, formed by a sloped load bed in a load bed notch, operating responsive to the permissive bale discharge method described in FIG. 104.

FIG. 112 illustrates a flowchart describing a selective bale discharge method for permitting a bale receiving portion of a load bed of an agricultural bale accumulator to discharge a bale, received along a bale receiving axis in a bale receiving direction, from the bale receiving portion of a load bed to a ground surface in a bale discharging direction, essentially the same as the bale receiving direction, either dependently or independently relative to a bale accumulating portion of the load bed discharging accumulated bales to the ground surface.

FIG. 113 illustrates, in a right side elevation view, an agricultural bale accumulator having a selective bale discharge apparatus operating responsive to selective bale discharge method described in FIG. 112, wherein the bale receiving portion of the load bed is located in a bale receiving position and the bale accumulating portion of the load bed is located in a bale accumulating position.

FIG. 114 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIG. 113, wherein the bale receiving portion of the load bed is located in the bale receiving position and the bale accumulating portion of the load bed is located in a bale discharging position.

FIG. 115 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIGs. 113 and 114, wherein each of the bale receiving portion of the load bed and the bale accumulating portion of the load bed is located in a bale discharging position.

FIG. 116 illustrates, in a top side planar view, the agricultural bale accumulator shown in FIGs. 113 - 115, wherein the bale receiving portion of the load bed is located in a bale receiving position and the bale accumulating portion of the load bed is located in a bale accumulating position.

FIG. 117 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIGs. 113 - 115, wherein the bale receiving portion of the load bed is located in the bale receiving position and the bale accumulating portion of the load bed is located in a bale discharging position.

FIG. 118 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIGs. 113 - 115, wherein each of the bale receiving portion of the load bed and the bale accumulating portion of the load bed is located in a bale discharging position.

FIG. 119 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIGs. 113 - 115, wherein the bale receiving portion of the load bed is located in the bale discharging position and the bale accumulating portion of the load bed is located in a bale accumulating position.

FIG. 120 illustrates a flowchart describing a bale speed discharge control method for controlling a discharge speed of bales accumulated on a load bed of an agricultural bale accumulator as the bales are discharged from the load bed to a ground surface responsive to a forward traveling direction of the agricultural bale accumulator.

FIG. 121 illustrates, in a top, rear and right side perspective view, an agricultural bale accumulator having a bale speed control discharge apparatus operating responsive to the bale speed discharge control method described in FIG. 120, wherein the load bed is located in a bale receiving and accumulating position.

FIG. 122 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIG. 121, wherein the load bed is located in a bale receiving and accumulating position and in a bale discharging position.

FIGs. 123 and 124 illustrate, each in a right side elevation view, the agricultural bale accumulator shown in FIGs. 121 and 122, wherein the load bed is located in a bale receiving and accumulating position and in a bale discharging position, respectively, and wherein the bale speed control discharge apparatus includes an accumulator traveling speed sensing mechanism.

FIG. 125 illustrates a flowchart describing a general field location control method for controlling operations, such as bale accumulation and/or bale discharge functions, of an agricultural bale accumulator responsive to a location of the agricultural bale accumulator in a field.

FIG. 126 illustrates a flowchart describing a particular field location control method for the general field locator control method described in FIG. 125 to adaptively control bale discharge functions of an agricultural bale accumulator responsive to the location of the agricultural bale accumulator in the field.

FIG. 127 illustrates, in an aerial view, a field showing a path of travel of an agricultural bale accumulator across the field while performing the field location control methods described in

FIGs. 126 and 127 and showing predetermined bale discharge zones in the field.

FIG. 128 illustrates a block diagram of an agricultural bale accumulator representing the agricultural bale accumulator and method therefor shown in FIGs. 1-127 and 129-132, wherein the agricultural bale accumulator has a controller with memory for storing all of the methods disclosed as flowcharts herein to control the agricultural bale accumulator and to manage external interfaces as disclosed herein.

FIG. 129 illustrates, in a rear side elevation view, an agricultural bale accumulator having a preferred combination of each of the apparatus disclosed herein.

FIG. 130 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIG. 129, wherein a load bed of the agricultural bale accumulator is located in a bale receiving and accumulating position relative to a main frame.

FIG. 131 illustrates, in a top side plan view, the agricultural bale accumulator shown in FIGs. 129 and 130.

FIG. 132 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIGs. 129 - 131, wherein the load bed is located in a bale discharging position relative to the main frame to permit bales accumulated on the load bed to be discharged to a ground surface.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I. Introduction

A. Summary Of The Figures

Generally referring to all the figures, FIGs. 1-132 illustrate an agricultural bale accumulator 100 ("accumulator") and method therefor comprising, individually or in any combination, the following modules.

FIGs. 1-42 illustrate a load bed extension module 102 having an extension table support system. FIGs. 1-10 illustrate an agricultural bale accumulator 100 having a first embodiment of a load bed extension module 102. FIGs. 11-23 illustrate an agricultural bale accumulator 100 having a second embodiment of the load bed extension module 102. FIGs. 24-40 illustrate an agricultural bale accumulator 100 having third through twelfth embodiments of the load bed extension module 102. FIG. 41 illustrates a schematic diagram of a hydraulic system for use with the agricultural bale accumulator 100 of FIGs. 1-132. FIG. 42 illustrates a table 212 illustrating thirty six embodiments of an extension table support system for the load bed extension module 102, including the twelve embodiments of the load bed extension module 102 illustrated in FIGs. 1-40, for use on and/or off a pivot axis for one or more extension tables..

FIGs. 43-73 illustrate a bale stacking module 332. FIGs. 43-61 illustrate a bale stacking method and apparatus, using a single load bed, that raises the bales above the load bed, lowers the bales below the load bed, or raises and/or lowers bales to form a stack of bales on the load bed. FIGs. 62-73 illustrate a bale stacking method and apparatus using multiple load beds that are either moveable or fixed relative to each other, wherein the accumulator 100 discharges the bales from the load bed to a ground surface either simultaneously to form stacks of bales on the ground surface or sequentially to form a single layer of bales on the ground surface.

FIGs. 74-80 illustrate a bale advancement module 798, including a method which is performed by one of a first apparatus, formed as a spiked cylinder, and a second apparatus, formed as a spiked conveyor.

FIGs. 81-83 illustrate a bale arrangement control module 832. FIG. 81 illustrates a flowchart describing a method to be performed by an embodiment of an apparatus shown in FIG. 82 and 128 to determine a dynamic arrangement of bales on the load bed of the accumulator, as shown in FIG. 83.

FIGs. 84-103 illustrate a bale stabilization module 899. FIGs. 84-91 illustrate a load bed leveling module 900. FIGs. 84, 92-103 illustrate a lateral bale stabilization module 966.

FIGs. 104-111 and 74-80 illustrate a permissive bale discharge module 1052. FIG. 104 illustrates a flowchart describing a method to be performed by one of five embodiments of an apparatus shown in FIGs. 105-111 or to be performed by the embodiment of method and apparatus shown in FIGs. 74-80.

FIGs. 112-119 illustrate a selective bale control module 1093. FIG. 112 illustrates a flowchart describing a method to be performed by an embodiment of an apparatus shown in FIGs. 113-119.

FIGs. 120-124 illustrate a bale speed discharge control module 1106. FIG. 120 illustrates a flowchart describing a method to be performed by an embodiment of an apparatus shown in FIGs. 121-124.

FIGs. 125 and 126 illustrate a field location control module. FIGs. 125 and 126 illustrate flowcharts describing a method to be performed by the accumulator 100, represented in FIG. 128, when traveling across a field shown in FIG. 127.

FIG. 128 illustrates a block diagram 128 of the accumulator 100 including each of the abovementioned modules. FIGs. 129-132 illustrate the accumulator 100 including each of the abovementioned modules.

B. Summary Of Operation

The load bed extension module 102 expands and supports a bale accumulating capacity of the accumulator 100 along a horizontal axis. The bale stacking module 332 expands a bale accumulating capacity of the accumulator 100 along a vertical axis. The bale advancement module 798 advances a fully formed bale onto a load bed 113 ahead of a successive bale to create a predetermined space 808 between the bales to permit the fully formed bale to be handled by the accumulator 100 in an amount of time before the successive bale travels through the predetermined space 808. The bale arrangement control module 830 permits a dynamic arrangement of bales to be accumulated on the accumulator 100 within a bale accumulating capacity of the accumulator 100. The bale stabilization module 899, provided by a load bed leveling module 900 and/or a lateral bale stabilization module 996, encourages the bales to remain at their accumulated positions on the accumulator prior to their discharge from the accumulator 100. The permissive bale discharge module 1052, provided by a sliding 1066, a hinged 1056 or a rotating 1068 bale support member, or a pivoting or a sloped 1074 load bed 113, or a bale advancement module 798, permits the accumulator 100 to discharge a bale accumulated on a center portion 114 of a load bed 113 along a bale receiving axis 201 without the load bed 113 interfering with a successively received bale. The selective bale discharge control module 1093 permits the accumulator 100 to selectively control a discharge of bales accumulated on a bale receiving portion 114 of a load bed 113 located along a bale receiving axis 201 and/or a bale accumulating portion 116, 118 of the load bed 113 located adjacent to the bale receiving portion 114. The bale speed discharge control module 1106 controls a discharge speed of bales accumulated on a load bed 113 to a ground surface 128 responsive to a traveling speed of the accumulator 100. The field location control module 1115 controls a bale accumulation operation and/or a bale discharge operation of the accumulator 100 responsive to a location of the accumulator in a field 1135. One or more of these modules advantageously provides the accumulator 100 with a large bale accumulating capacity and intelligent bale accumulation and bale discharge operations to permit efficient, flexible and desirable harvesting of hay and forage.

C. Reference Diagram

Generally referring to all the figures showing the accumulator 100 as a mechanical apparatus, for the sake of convenience and facilitating a better understanding the preferred embodiments, the figures include a reference diagram illustrating three dimensions and should not

limit the scope of the present invention. The reference diagram includes a first axis 201, a second axis 202 and a third axis 203. The reference diagram used in conjunction with the agricultural bale accumulator 100 and/or components thereof is determined with reference to the orientation of agricultural bale accumulator 100. The first axis 201 lies along a longitudinal axis of the agricultural bale accumulator 100. The second axis 202 lies along a lateral axis of the agricultural bale accumulator 100 and is transverse to the first axis 201. A third axis 203 lies in a vertical relationship to the agricultural bale accumulator 100 and is transverse to both the first axis 201 and the second axis 202.

Arrows on the ends of each of the first axis 201, the second axis 202 and the third axis 203 are numbered to indicate direction along each of the three axis. On the first axis 201, arrows 221 and 222 represent a forward direction and a rearward direction, respectively. On the second axis 202, arrows 223 and 225 represent a right direction and a left direction, respectively. On the third axis 203, arrows 225 and 226 represent an upward direction and a downward direction, respectively. For example, the direction of forward operative travel of the agricultural bale accumulator is in the forward direction represented by arrow 221 along the first axis 201.

II. Base Module

FIGs. 1 and 2 illustrate, in a top, rear and right side perspective view, the agricultural bale accumulator 100 having a first embodiment of a load bed extension module 102 including a first extension table 104 and a second extension table 106 each being located in an unstowed position and a stowed position, respectively, and a portion 116 and 118 of the load bed 113 being located in a bale accumulating position. FIGs. 11 and 12 illustrate, in a top 109, rear 119 and right 124 side perspective view, an agricultural bale accumulator 100 having a second embodiment of a load bed extension module 102 including a first extension table 104 and a second extension table 106 each being located in an unstowed position and a stowed position, respectively, and a portion 116 and 118 of the load bed 113 being located in a bale accumulating position.

The bale accumulator 100 has a modular construction and generally comprises a base module 112, the load bed extension module 102, a bale transfer module 186, and a bale discharge module 116, 118, 190. In the preferred embodiments, the base module 112 comprises a main frame 102 for supporting a load bed 113 and a pair of ground engaging castor wheels 108 and 109 for supporting the main frame 102 above a ground surface 128.

The accumulator 100 is adapted to be pulled in tandem behind an agricultural baler 101 ("baler") in a direction of travel 221 across a ground surface 128. The load bed 113 is substantially planar and receives a plurality of bales, including a first bale followed by a second bale, from a bale chamber 103 of the agricultural baler 101 along the first bale receiving axis 201. The plurality of bales are ejected from a bale chamber 103 of the baler 101 at a first rate of speed along the bale receiving axis 201 in a bale traveling direction 222 essentially opposite to the direction of travel 221 of the baler 101 and the accumulator 100. The second bale contacts the first bale to eject the first bale from the bale chamber 103 of the baler 101 to cause the first bale to be received on the load bed 113 along the bale receiving axis 201 in the bale traveling direction 222. The first bale is completely formed and tied when the first bale is ejected from the bale

chamber 103 of the baler 101. Alternatively, the plurality of bales may be retrieved from the ground surface 128 after having been discharged from the bale chute 103 of the baler 101.

The load bed includes a center load bed 114, a right load bed 116 and a left load bed 118. As will be described with reference to FIGs. 3, 4, 11 and 12, the portion 116 and 118 of the load bed 113 moves between a bale accumulating position and a bale discharging position while the center load bed 114 remains in a fixed position relative to the main frame 120.

The base module 112 supports the load bed extension module 102 which is operative to receive and accumulate additional bales, the bale-transfer module 186 which is operable to displace bales transversely on the load bed 113 and bale-discharge module 116, 118, 190 which is operative to discharge bales to the ground. Each of the load bed extension module 102, the bale-transfer module 186 and the bale-discharge module 116, 118, 190 will be described in detail hereinbelow.

As shown in FIGs. 1 and 11, each of the first 104 and second 106 extension tables are substantially co-planar with the load bed 113 and adjacent to a first side 124 and a second side 126, respectively, of the load bed 113 when each of the first 104 and second 106 extension tables are in the unstowed position to permit each of the first 104 and second 106 extension tables to accumulate thereon at least one of the plurality of bales received on the load bed 113. As shown in FIG. 2, each of the first 104 and second 106 extension tables are substantially raised to an inclined position relative to the load bed 113 when each of the first 104 and second 106 extension tables are in the unstowed position to permit the bale accumulator 100 to be stored or to be transported on a public roadway.

In the preferred embodiment, the bale accumulator 100 has a lateral width dimension 161 of approximately 548 cm when each of the first 104 and second 106 extension tables are in the unstowed position and a lateral width dimension 160 of approximately 335 cm when each of the first 104 and second 106 extension tables are in the stowed position. Therefore, a lateral width dimension of the load bed 113 is increased by 213 cm. With these lateral width dimensions, the bale accumulator 100 is permitted to accumulate up to five medium sized bales on the load bed 113 across the lateral axis 202 of the load bed 113 when each of the first 104 and second 106 extension tables are in the unstowed position.

By contrast, U.S. Patent Nos. 4,961,679 and 4,955,774 teaches the accumulation of up to only four bales across a lateral axis of the load bed, U.S. Patent No. 4,844,675 teaches the accumulation of up to only three bales across a lateral axis of the center, right and left tables, and Holescher's bale accumulator Model 1030 teaches the accumulation of up to only three bales across a lateral axis of load bed. Therefore, the bale accumulator 100 of the present invention increases the bale accumulating capacity along a lateral axis of a bale accumulator by one or two additional bales over that provided by the bale accumulators described in these references to increase the bale accumulator's bale accumulating efficiency by 25% and 66%, respectively.

As shown in FIGs. 1 and 2, the portion 116 and 118 of the load bed 113 is located in a bale accumulating position which is a horizontal position relative to the main frame 120 to permit

the load bed 113 and the first 104 and second 106 extension tables to accumulate thereon the plurality of bales.

The bale accumulator 100 is hitched or attached to the agricultural baler 101, which is partially shown in FIGs. 1-5, 11-15, and 19 of the drawings, by a coupling device comprising, on one hand, a ring or eye bolt attached to a main frame 120 of the bale accumulator 100 and disposed to enter in to a socket coupled to the main frame 120 and to receive a coupling pin therethrough and, on the other hand, a pair of transversely spaced apart tie rods provided at opposite ends of the eye bolt. Each tie rod is attached at its opposite ends to the baler 101 and the main frame 120 by ball joints. In an alternative arrangement only one such tie rod is provided. With this form of hitching or connection, the accumulator 100 cannot move in yaw relative to the baler 101 on the one hand while limited movement in the two other main connections is allowed on the other hand. Indeed, the bale accumulator 100 and the baler 101 can move relative to each other to a limited degree in pitch about the ball joints and the eye bolt and in addition thereto the coupling device allows the accumulator and the baler to move relative to each other about a longitudinal, fore-and-aft axis of the two components. The inability of the baler 101 and the bale accumulator 100 to move relative to each other in yaw requires that the two ground-engaging-wheels 108 and 110 of the bale accumulator 100 are castor wheels which are pivotable about generally vertical axes. The foregoing arrangement is necessary to guarantee that, in use, the bales emerging from a bale chamber 103 of the baler 101 are always received at precisely the same location on the bale accumulator 100 by virtue of the accumulator 100 always having a bale receiving portion a load bed 114 properly aligned with the bale chamber 103. However, for transport purposes, the bale accumulator 100 should be able to assume, when seen in a horizontal plane, an angled position relative to the pulling baler 101. To this end, the tie rods are removed and the castor wheels are secured in their fixed positions relative to the main frame 120 whereby the accumulator 100 becomes a conventional trailed unit.

III. Bale Transfer Module

The bale transfer module distributes a plurality of bales received on the load bed 113 across the load bed 113 and the first and second extension tables 104 and 106 to accumulate the plurality of bales on the load bed 113 and the first and second extension tables 104 and 106 in a side by side relationship when the first and second extension tables 104 and 106 are each in the unstowed position and when the portion 116 and 118 of the load bed 113 is in the bale accumulating position.

In the preferred embodiments, the bale transfer module 186 comprises a push bar 186 operable to alternately transfer bales transversely across the load bed 113 along the second axis 202 as they are received onto the load bed 113 from the bale chute 103 of the baler 101. The push bar 186 and its associated drive mechanism is known in the bale accumulator art as shown in U.S. Patent Nos. 4,961,679, 4,955,774 and 4,844,675, herein incorporated by reference, Holescher's bale accumulator Model 1030, and Case IH Corporation's bale accumulator Model 8576, for example, referred to hereinabove in the Background of the Invention section.

Alternatively, other types of bale transfer modules may be implemented the bale accumulator 100 without departing from the spirit of the present invention. Such other bale transfer modules may include for example, a robotic arm assembly as shown in U.S. Patents 4,961,679, 4,955,774 or a moveable platform as shown in U.S. Patents 4.710,086 and 4,710,087, each of which is herein incorporated by reference.

IV. Bale Discharge Module

FIGs. 3 and 4 illustrate, in a top, front and right side perspective view and a top, rear and right side perspective view, respectively, the agricultural bale accumulator 100 of FIG. 1 having the first embodiment of the load bed extension module 102 including the first extension table 104 and the second extension table 106 each being located in the unstowed position and a portion 116 and 118 of the load bed 113 being located in a bale discharging position. FIGs. 13 and 14 illustrate, in a top 109, front 117 and right 124 side perspective view and a top 109, rear 119 and right 124 side perspective view, respectively, the agricultural bale accumulator 100 of FIG. 11 having the second embodiment of the load bed extension module 102 including the first extension table 104 and the second extension table 106 each being located in the unstowed position and the portion 116 and 118 of the load bed 113 being located in a bale discharging position.

In the preferred embodiments, the bale discharge module comprises the portion 116 and 118 of the load bed 113 and a hydraulic cylinder 190. The portion 116 and 118 of the load bed 113 is pivotally connected to the main frame 120 about a pivot point 188 disposed on a horizontal pivot axis 146 and moveable relative to the main frame 120 between the bale accumulating position and the bale discharging position. The portion 116 and 118 of the load bed 113 is in a horizontal position relative to the main frame 120 when the portion 116 and 118 of the load bed 113 is in the bale accumulating position to permit portion 116 and 118 of the load bed 113 and the first extension table 104 to accumulate thereon the plurality of bales. The portion 116 and 118 of the load bed 113 is in an inclined position relative to the main frame 120 when the load bed 113 is in the bale discharging position to permit the portion 116 and 118 of the load bed 113 and the first 104 and second 106 extension tables to discharge the plurality of bales accumulated thereon to the ground surface 128.

Alternatively, other types of bale transfer modules may be implemented the bale accumulator 100 without departing from the spirit of the present invention. Such other bale discharge modules may include for example, conveyor chains having push plates which push the accumulated bales off a horizontal load bed to the ground as shown in U.S. Patents 4,961,679 and 4,955,774, each of which is herein incorporated by reference. An advantage of this embodiment for a bale discharge module is that the load bed is rigidly fixed to the main frame to provide a stable support for the accumulated bales during the bale accumulating and bale discharging operations.

Still an other bale discharge modules may include, for example, a load bed pivotally mounted on to a main frame and moveable between a bale accumulating position and a bale discharging position so that when the load bed is unlatched the load bed tilts downwardly at the rear of the load bed under the force of gravity action on the weight of the bales to permit the bales

carried thereon to slide to the ground as the bale accumulator continues its forward movement. When the weight of the bales is removed from the load bed a spring or a counterweight provided by a weight of the load bed pulls the load bed to its latched position. An advantage of this embodiment for a bale discharge module is that a hydraulic dump cylinder is not needed to forcibly raise the load bed and the bales accumulated thereon to its bale discharging position.

V. Load Bed Extension Module

With continuing reference to the first and second embodiments shown in FIGs. 1-4 and 11-14, the load bed extension module 102 generally includes a first extension table 104, a first extension table attachment mechanism 122 and a first extension table support system 130. While the following description of the load bed extension module 102 will be given with reference to the first, right side 124 of the load bed 113, the load bed extension module 102 is also intended to apply to the second, left side 126 of the load bed 113 in a similar manner as that described for first, right side 124 of the base module 112. However, while use of the load bed extension module 102 on each side of the load bed 113 is preferred, the load bed extension module 102 is not required to be used on both sides of the base module at the same time.

A. Extension Table Attachment Mechanism

The first extension table attachment mechanism connects the first extension table 104 to the base module 112 to permit the first extension table 104 to be moveable relative to the base module 112 between the stowed position and the unstowed position. The stowed and unstowed positions are described hereinabove.

In the preferred embodiment, the first extension table attachment mechanism is a hinge 122 located on a first hinge axis 136. Likewise, the second table is connected to the second side 126 of the base module 112 with a hinge 123 disposed along a second hinge axis 138. Alternatively, the first extension table attachment mechanism may be a telescoping mechanism as shown in FIG. 40 and described in further detail herein below.

In the preferred embodiment, the first extension table 104 is connected to the right load bed portion 116 of the load bed 113 and permitted to move with the right load bed portion 116 of the load bed 113 moves between the bale accumulating position and the bale discharging position. This arrangement permits the bale accumulator 100 to discharge any bales located on the right 116 and left 118 portions of the load bed 113 and the first 104 and second 106 extension tables at the same time by moving the right 116 and left 118 portions of the load bed 113 to the bale discharging position relative to the main frame 120. Alternatively, the load bed extension module 102 is equally well suited for use with a bale discharge module wherein a load bed does not tilt relative to a main frame, such as the chain driven push plates described hereinabove. In this alternative case, the first 104 and second 106 extension tables can be attached directly to the main frame, as opposed to the load bed, if so desired.

B. Extension Table Support System

The first extension table support system 130 is connected to at least one of the base module 112 and the first extension table 104. The first extension table support system 130 contacts the first extension table 104 at a location beyond the first side 124 of the load bed 113 and

contacts at least one of the base module 112 and the ground surface 128 to support the first extension table 104 from at least one of the base module 112 and the ground surface 128, respectively, when the first extension table 104 is in the unstowed position.

Generally, the first extension table support system 130 comprises five embodiments which will be described in detail below. The first embodiment of the first extension table support system 130 utilize a support wheel 164. The second, third, fourth and fifth embodiments of the first extension table support system 130 utilize a first 140, second 150, third 154 and fourth 192 frame extension members, respectively. For the sake of convenience and to facilitate a better understanding of the present invention, embodiments of the first 140, second 150, third 154 and fourth 192 frame extension members comprise a truss member, a collapsible cylinder, a fixed frame member and a moveable frame member, respectively, which should not limit the spirit and scope of the present invention.

The support wheel 164 will be described in further detail with reference to the first, third, fourth, sixth, seventh, eleventh, and twelfth embodiments of the load bed extension module 102, as shown in FIGs. 1-10, 24 and 25, 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively. The truss member of the first frame extension member 140 will be described in further detail with reference to the first, second, fifth, seventh, eight and ninth embodiments of the load bed extension module 102, as shown in FIGs. 1-10, 11-23, 28 and 29, 32 and 33, 34 and 35, and 36 and 37, respectively. The collapsible cylinder of the second frame extension member 150 is described with reference to the first, second, and ninth embodiments of the load bed extension module 102, as shown in FIGs. 1-10, 11-23, and 36 and 37, respectively. The fixed frame member of the third frame extension member 154 will be described in further detail with reference to the second, fourth, and fifth, embodiments of the load bed extension module 20, as shown in FIGs. 11-23, 26 and 27, and 28 and 29, respectively. The moveable frame member of the fourth frame extension member 192 will be described in further detail with reference to the fourth, sixth, seventh, eleventh and twelfth embodiments of the load bed extension module 20, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively.

The first extension table support system 130 contacts the first extension table 104 at a location beyond the first side 124 of the load bed 113. Likewise, a second extension table support system contacts the second extension table 106 at a location beyond the second side 126 of the load bed 113. For the first extension table 104, the location where the contact is made is further described as being beyond the first hinge axis 136 where the first extension table 104 is attached to the load bed 133. Preferably, a location of contact on the first extension table 104 between a center portion and a distal side of the first extension table 104 is optimal.

By contrast, U.S. Patent Nos. 4,961,679, 4,955,774 and 4,844,675 and Case IH Corporation's bale accumulator Model 8576 do not disclose a support system which contacts an extension table at a location beyond a side of a base module to which the extension table is attached. Each of these references merely show an extension table hinged to the base module without any support beyond the hinge area.

When used alone, the support wheel 164 supports the first extension table 104 from the ground surface 128 when the first extension table 104 is in the unstowed position. When used alone, each of the first 140, second 150, third 154 and fourth 192 frame extension members support the first extension table 104 from the base module 112 when the first extension table 104 is in the unstowed position. When used in combination, the support wheel 164 and one of the first 140, second 150, third 154 and fourth 192 frame extension members support the first extension table 104 from the ground surface 128 and the base module 112 when the first extension table 104 is in the unstowed position.

In the preferred embodiment, the first extension table support system 130 further supports the first extension table 104 from at least one of the base module 112 and the ground surface 128 the when the portion 116 and 118 of the load bed 113 is at least one of the bale accumulating position and the bale discharging position. It is especially important to note that when the portion 116 and 118 of the load bed 113 is moved to the bale discharging position about the pivot axis 146, as shown in FIGs. 3, 4, 13 and 14, there is a large amount of space between the portion 116 and 118 of the load bed 113 and the main frame 120. In the bale discharging position, the portion 116 and 118 of the load bed 113 is supported from the main frame 120 with the hydraulic cylinder 190 which is used to forcibly tilt the portion 116 and 118 of the load bed 113 relative to the main frame 120. However, according to the present invention, the first 104 and second 106 extension tables attached to the portions 116 and 118 of the load bed 113, respectively, also need support when the portion 116 and 118 of the load bed 113 is located in at least one of the bale accumulating position and the bale discharging position. During the operation of the bale accumulator 100 in a field, the bale accumulator 100 is subject to a normally present, rough and varying ground surface causing the weight of the bales to bounce or shift on the first 104 and second 106 extension tables. Without the extension table support system 130 of the present invention, such bouncing and shifting will cause wear and fatigue on the hinges 122 and 123 connecting the first 104 and second 106 extension tables to the load bed 113. An abnormal amount of wear and fatigue on the hinges 122 and 123 will inhibit proper movement of the first 104 and second 106 extension tables between their stowed and unstowed positions or cause permanent damage to the hinges 122 and 123, the load bed 113 and/or the first 104 and second 106 extension tables.

The first extension table support system 130 of the present invention can support the first extension table 104 "on" the horizontal pivot axis 146, "off" the horizontal pivot axis 148, or both "on" and "off" the horizontal pivot axis 146. The first extension table support system 130 provides support "on" pivot axis 146 when the first extension table support system 130 supports the first extension table 104 about the horizontal pivot axis 146 when the first extension table 104 is in the unstowed position and when the at least a portion 116 and 118 of the load bed 113 is moves between the bale accumulating position and the bale discharging position. A pivot point 188 at the connection between the load bed 113 and the main frame 120 forms the horizontal pivot axis 146. The support "on" the pivot axis is described with reference to each of the twelve embodiments of the load bed extension module 20, as shown in FIGs. 1-40, respectively. Note

that the third through twelfth embodiments of the load bed extension module 20, as shown in FIGs. 24-40 may be implemented either "on" the pivot axis 146 or "off" the pivot axis 148.

The first extension table support system 130 provides support "off" the pivot axis 148 when the first extension table support system 130 supports the first extension table 104 at a location between a front side 117 of the load bed 113 where the plurality of bales are received on the load bed 113 and the horizontal pivot axis 146 when the first extension table 104 is in the unstowed position and when the portion 116 and 118 of the load bed 113 is in the bale accumulating position. The support "off" the pivot axis is described with reference to each of the twelve embodiments of the load bed extension module 20, as shown in FIGs. 1-40, respectively.

The first extension table support system 130 of the present invention can support more that one extension table disposed on the same side of the load bed. The extension table support system 130 of the present invention becomes even more important in this case because the multiple extension tables and any bales accumulated thereon are located at a position far away from the main frame 120. Without the extension table support system 130 of the present invention, the weight of multiple bales on multiple tables extending away from the main frame 120 greatly increases the amount of stress on the hinges 122 and 123. If there are two or more extension tables disposed on the same side of the load bed, the extension table support system 130 of the present invention may even be considered essential to meet minimum standards of durability and usefulness while the bale accumulator is being used in a field over the useable life time of the bale accumulator 100. The application of the extension table support system 130 to multiple extension tables disposed on the same side of the load bed 113 will be described in further detail with reference to FIGs. 24-40.

The need for extension table support system 130 of the present invention is dependent on the construction of the base module 112. In each of the first and second embodiments of the load bed extension module 102, as shown in FIGs. 1-23, the load bed extension module 102 is adapted to a bale accumulator Model 1030, manufactured by Hoelscher, Inc., 312 S. Main, P.O Box 195, Bushton, Kansas, U.S.A., 67427. The main frame 120 and the load bed 113 of the base module 112 of Hoelscher's bale accumulator Model 1030 is not built of construction materials durable enough to support the weight of a load bed extension table 104 and any bales accumulated thereon without the assistance of the extension table support system 130 of the present invention. Therefore, the extension table support system 130 of the present invention becomes essential to providing a durable bale accumulator 100 having the load bed extension module 102 when the load bed extension module 102 is retrofitted to an existing bale accumulator which was not manufactured with the expectation that the load bed extension module 102 would be attached.

The need for extension table support system 130 of the present invention is also dependent on the manufacturing cost of the bale accumulator 100. As shown on Case IH Corporation's bale accumulator Model 8576, extension tables are provided without any support contacting the extension table beyond the hinge connecting the extension table to the load bed. On Case IH Corporation's bale accumulator Model 8576, the only support for the extension table is where a

side of the extension table contacts a side of the load bed below the hinge when the extension table is folded down to be coplanar with the load bed. The lack of support for the extension tables is overcome by constructing the main frame, the load bed and the extension tables with very heavy duty materials. However, disadvantages associated with building a heavy duty bale accumulator include increasing the cost of the bale accumulator, increasing the amount of fuel used to pull the bale accumulator, etc. The extension table support system 130 of the present invention is advantageous because it cost less to implement than using heavy duty materials and it weighs less than the heavy duty materials while providing a durable design. Further, even if heavy duty materials are used, the extension table support system 130 of the present invention is advantageous for multiple extension tables disposed on the same side of the load bed.

1. Support Wheel

The support wheel 164 is described with reference to the first, third, fourth, sixth, seventh, eleventh, and twelfth embodiments of the load bed extension module 20, as shown in FIGs. 1-10, 24 and 25, 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively.

In the first and third embodiment of the load bed extension module 102, as shown in FIGs. 1-10, 24 and 25, respectively the first extension table support system 130 includes a first support wheel 164 connected to the first extension table 104 and moveable with the first extension table 104 when the first extension table 104 moves between the stowed position and the unstowed position. The first support wheel 164 contacts the ground surface 128 to support the first extension table 104 from the ground surface 128. The first support wheel 164 advantageously provides support along the vertical axis 203 in the upward direction 225 relative to the extension table.

In the fourth, sixth, seventh, eleventh, and twelfth embodiments of the load bed extension module 20, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively, the support wheel is connected to the moveable frame member of the fourth frame extension member 192 and will be described in further detail hereinbelow.

In the preferred embodiment, the first wheel 108, the second wheel 110, the first support wheel 164, as well as the second support wheel 166 on the second extension table 106 share a common axis of rotation 134 to encourage a smooth ride for the bale accumulator 100 across a field.

2. First Frame Extension Member (ex: truss)

The truss member of the first frame extension member 140 is described with reference to the first, second, fifth, seventh, eight and ninth embodiments of the load bed extension module 20, as shown in FIGs. 1-10, 11-23, 28 and 29, 32 and 33, 34 and 35, and 36 and 37, respectively.

The first extension table support system 130 further comprises a first frame extension member 140 connected to the first extension table 104 and moveable with the first extension table 104 when the first extension table 104 moves between the stowed position and the unstowed position. An end surface of the first frame extension member 140 contacts an end surface of the base module 112 to support the first extension table 104 from the base module 112.

In the first embodiment of the load bed extension module 20. FIGs. 7-10 are particularly well suited for illustrating a truss member of the first frame extension member 140 providing support "on" the pivot axis 146. FIG. 7 shows the truss member of the first frame extension member 140 attached to a bottom side of the left side extension table 106 near the left side support wheel 166. FIGs. 8, 9 and 10 show the truss member of the first frame extension member 140 attached to the bottom side of the left side extension table 106, the pivot point 188 of the base module 112 disposed on the pivot axis 146, and a pivot point spacer 162.

In the first embodiment of the load bed extension module 102 the truss member of the first frame extension member 140 contacts the base module 112 at the pivot point 162 to support for the second extension table 106 when the second extension table 106 is located in the unstowed position and when the portion 116 of the load bed 113 is located in the bale accumulating position. The pivot point spacer 162 is used to fill a gap between the pivot point 188 on Holescher's bale accumulator Model 1030 and an end of the truss member of the first frame extension member 140. Such a spacer would not be required on a new design for a bale accumulator.

In the first embodiment of the load bed extension module 102 the truss member of the first frame extension member 140 contacts the base module 112 at the pivot point 162 to support for the second extension table 106 when the second extension table 106 is located in the unstowed position and when the portion 116 of the load bed 113 is located in the bale discharging position. It is critical to note in this view that the truss member of the first frame extension member 140 is the only support for the first extension table 104 beyond the first hinge 122. Supporting the first extension table from the pivot point 162 on the pivot axis 146 is important to reduce wear and fatigue on the hinge 122 when the first extension table is moved to the bale discharging position. Therefore, supporting the extension table from the pivot point using the truss member of the first frame extension member 140 provides a significant advantage over that presently available in the prior art.

In the first embodiment of the load bed extension module 20, FIGs. 5-7 are particularly well suited for illustrating a truss member of the first frame extension member 140 providing support "off" the pivot axis 148.

In FIG. 5 the general area of interest showing the truss member of the first frame extension member 140 is at the front, right corner of the bale accumulator 100.

FIG. 6 shows the truss member of the first frame extension member 140 contacting the main frame 120 from "off" the pivot axis 148. Preferably, the "off" axis is located near the front 117 of the bale accumulator 100 to provide even support in combination with the truss member of the first frame extension member 140 contacting the base module 112 at the pivot point 162. Preferably, the truss member of the first frame extension member 140 contacts the main frame 120.

FIG. 6 also appropriately shows a mating contact between an end surface 142 of the first frame extension member 140 an end surface 144 on the base module 112. The end surface 142 of the first frame extension member 140 has a downward angle relative to a horizontal axis when the first extension table 104 is in the unstowed position. The end surface 144 on the base module 112

has an upward angle relative to the horizontal axis which is complementary to the downward angle. The end surface 142 the first frame extension member 140 contacts the end surface 144 on the base module 112 to translate an upward force through the first frame extension member 140 to support the first extension table 104 from the base module 112. The complimentary angles advantageously direct a larger component of force from the base module 112 to the first extension table 104.

FIG. 7 shows a separation between the end surface 142 of the first frame extension member 140 the end surface 144 on the base module 112 when the second, left side extension table is in the stowed position.

In the second embodiment of the load bed extension module 20, FIGs. 15-20, and 22 are particularly well suited for illustrating a truss member of the first frame extension member 140 providing support "off" the pivot axis 148. FIGs. 15-20, and 22 show the first frame extension member 140 having three truss members. Each of the three truss members contact the fixed frame member of the third frame extension member 154 which will be described in further detail hereinbelow. Each of the three truss members contacts the fixed frame member of the third frame extension member 154 in a similar manner to the way the truss member contacts that main frame 120 as described hereinabove with the first embodiment of the load bed extension module 102. Although three truss members are shown which provide superior support along the length first extension table 104, only one truss member near the front 117 of the bale accumulator 100 can be used to provide adequate support "off" the pivot axis.

The truss member of the first frame extension member 140 is described with reference to the fifth, seventh, eight and ninth embodiments of the load bed extension module 102, as shown in FIGs. 32 and 33, 34 and 35, and 36 and 37, respectively. In FIGs. 32 and 33, the truss member of the first frame extension member 140 is attached to a third extension table 105 and contacts the moveable frame member of the fourth frame extension member 192. This embodiment is advantageous in reducing the distance traveled by the moveable frame member of the fourth frame extension member 192. In FIGs. 34 and 35, a truss member of the first frame extension member 140 is attached to each of the first extension table 104 and the third extension table 105 to build a continuous truss support for each of the first extension table 104 and the third extension table 105 when each of the first extension table 104 and the third extension table 105 are in the unstowed position. This embodiment is advantageous because no moveable parts are needed to support the extension tables. In FIGs. 36 and 37, the truss member of the first frame extension member 140 is attached to a third extension table 105 and contacts a lower part of the first extension table 104. This embodiment is advantageous in reducing the travel of the cylinder 150 which would support a wider extension table.

3. Second Frame Extension Member (ex: cylinder)

The collapsible cylinder of the second frame extension member 150 is described with reference to the first, second, and ninth embodiments of the load bed extension module 102, as shown in FIGs. 1-10, 11-23, and 36 and 37, respectively.

The first extension table support system 130 further comprises a second frame extension member 150 having a first end connected to the base module 112 and a second end connected to the first extension table 104 and being moveable between a collapsed position and an expanded position. The second frame extension member 150 is in the collapsed position when the first extension table 104 is in the unstowed position, wherein the second frame extension member 150 is in the expanded position when the first extension table 104 is in the stowed position. The second frame extension member 150 is connected to the first extension table 104 and the base module 112 to support the first extension table 104 from the base module 112.

In the first, second, and ninth embodiments of the load bed extension module 102, as shown in FIGs. 1-10, 11-23, and 36 and 37, respectively, the second frame extension member 150 further comprises a first hydraulic cylinder 150 for moving the first extension table 104 between the stowed position and the unstowed position responsive to receiving pressurized hydraulic fluid from a hydraulic fluid source 115. FIG. 41 shows the hydraulic fluid source 115. Alternatively, the second frame extension member 150 can be a telescoping frame member which provides equivalent support as the hydraulic cylinder 150 for the first extension table 104 but does not permit assistance from the hydraulic fluid source. In this case the extension table would require manual assistance.

In the second and ninth embodiments of the load bed extension module 102, as shown in FIGs. 15-17, 19-21-23; and 36 and 37, respectively, the second frame extension member 150 is connected to the main frame 120 of the base module 112 "on" the pivot axis 146. These embodiments advantageously provide a combination of support for the extension table and hydraulic assistance. In the first embodiment of the load bed extension module 102, the second frame extension member 150 is connected to the load bed 113 of the base module 112 "off" the pivot axis 148. The embodiment advantageously provides additional support for the extension table 104 from above the extension table 104 in addition to the support on the pivot point 162 provided by the truss member of the first frame extension member 140.

In the first and second embodiments of the load bed extension module 102, as shown in FIGs. 1-10 and 11-23, respectively, the agricultural bale accumulator 100 further comprises the second hydraulic fluid cylinder 190 having a first end connected to the main frame 120 and a second end connected to the portion 116 and 118 of the load bed 113. The second cylinder 190 moves the portion 116 and 118 of the load bed 113 relative to the main frame 120 between the bale accumulating position and the bale discharging position responsive to receiving pressurized hydraulic fluid from the hydraulic fluid source 115, as shown in FIG. 41. FIG. 41 illustrates a schematic diagram of a hydraulic system for use with the agricultural bale accumulator of FIGs. 1 and 23. A hydraulic valve 214, as shown in FIG. 41, selectively routes the pressurized hydraulic fluid from the hydraulic fluid source 115 to one of the first hydraulic cylinder 150 and the second hydraulic cylinder 190 responsive to an electric control signal 216. This embodiment advantageously permits hydraulic power to be used to move the extension table 104 when there are a limited number of hydraulic sets of ports available from a tractor carrying the hydraulic fluid source 115. In the preferred embodiment, the tractor used to pull the baler 101 and the bale

accumulator 100 only has three hydraulic sets of ports: a first set is used to by the baler 101 to bale the crop into bales, a second set is used by the bale accumulator 100 to operate the bale transfer module 186, a third set to operate the bale discharge module 116, 118, and 190. Therefore, one set is lacking to move the extension tables between their stowed and unstowed positions. Therefore, the third set of hydraulic ports is advantageously shared between the bale discharge module 116, 118, and 190 and the load bed extension module 102.

In the first and second embodiments of the load bed extension module 102, as shown in FIGs. 1-10 and 11-23, respectively, the second frame extension member 150 further comprises at least one spring member 152, connected to at least one of the base module 112, the first extension table 104 and the second frame extension member 150, for exerting a bias force on the first extension table 104 when the first extension table 104 is moved to at least one of the stowed position and the unstowed position. This embodiment advantageously pulls the collapsible frame member over its center point when moving the extension table 104 to the stowed position. In the first embodiment of the load bed extension module 102, the spring is connected to a front, top side of the first extension table 104 and to a distal end of the hydraulic cylinder 150. In the second embodiment of the load bed extension module 102, the spring is connected to a bottom side of the first extension table 104 and to a distal end of the hydraulic cylinder 150.

4. Third Frame Extension Member (ex: fixed frame)

The fixed frame member of the third frame extension member 154 is described with reference to the second, fourth, and fifth, embodiments of the load bed extension module 20, as shown in FIGs. 11-23, 26 and 27, and 28 and 29, respectively.

In the second, fourth, and fifth, embodiments of the load bed extension module 20, as shown in FIGs. 11-23, 26 and 27, and 28 and 29, respectively, the first extension table support system 130 further comprises a third frame extension member 154 having a proximal end 156 and a distal end 158. The proximal end 156 of the third frame extension member 154 is connected to the main frame. The distal end 158 of the third frame extension member 154 extends beyond the main frame 120 in a direction transverse to a traveling direction of the agricultural bale accumulator 100 at a fixed position which is located inside a road travel width dimension 160 of the agricultural bale accumulator 100 to permit safe traveling of the agricultural bale accumulator 100 on a public roadway when the first extension table 104 is in the stowed position. A first portion of the first extension table 104 is positioned inside the distal end 158 of the third frame extension member 154 and a second portion of the first extension table 104 is positioned outside the distal end 158 of the third frame extension member 154 when the first extension table 104 is in the unstowed position to permit the third frame extension member 154 to contact the first extension table 104 between the first portion of the first extension table 104 and the second portion of the first extension table 104 to support the first extension table 104 from the main frame 120.

These embodiments advantageously provide support for the extension table 104 with no moving parts. Further, the third frame extension member 154 is positioned directly beneath the

extension table 104 to provide a component of force along the vertical axis 203 in an upward direction 225.

5. Fourth Frame Extension Member (ex: moveable frame)

The moveable frame member of the fourth frame extension member 192 is described with reference to the fourth, sixth, seventh, eleventh and twelfth embodiments of the load bed extension module 102, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively.

In the fourth, sixth, seventh, eleventh and twelfth embodiments of the load bed extension module 102, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively, the first extension table support system 130 further comprises a fourth frame extension member 192 and a frame attachment mechanism 218. The fourth frame extension member 192 has a proximal end 156 and a distal end 158. The frame attachment mechanism 218 is connected to the proximal end 156 of the fourth frame extension member 192 and the main frame 120 to permit the distal end 158 of the fourth frame extension member 192 to be moveable relative to the main frame 120 between a stowed position and an unstowed position. The distal end 158 of the fourth frame extension member 192 moves towards the main frame 120 when the fourth frame extension member 192 is in the stowed position, wherein the distal end 158 of the fourth frame extension member 192 moves away from the main frame 120 when the fourth frame extension member 192 is in the unstowed position, wherein the distal end 158 of the fourth frame extension member 192 contacts the first extension table 104 to support the first extension table 104 from the main frame 120 when the fourth frame extension member 192 is in the unstowed position.

In the fourth, sixth, seventh, eleventh and twelfth embodiments of the load bed extension module 102, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively, the frame attachment mechanism 218 further comprises a telescoping mechanism for telescopically connecting the proximal end 156 of the fourth frame extension member 192 to the main frame 120 along a horizontal axis 146 or 148 relative to the main frame 120. Preferably, the frame attachment mechanism 218 telescopes from the main frame along the pivot axis 146 to provide support for the extension tables when moved to at least one of the bale accumulating position and the bale discharging position. Alternatively, the frame attachment mechanism 218 may telescope from the main frame "off" the pivot axis 148. Alternatively, the frame attachment mechanism 218 further comprises a pivoting mechanism for pivotally connecting the proximal end 156 of the fourth frame extension member 192 to the main frame 120 about a vertical axis 198 relative to the main frame.

In the fourth, sixth, seventh, eleventh and twelfth embodiments of the load bed extension module 102, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, 39, and 40, respectively, the first extension table support system 130 further comprises a first support wheel 164 connected to the distal end 158 of the fourth frame extension member 192 and moveable with the fourth frame extension member 192 when the fourth frame extension member 192 moves between the stowed position and the unstowed position. The first support wheel 164 contacts the ground surface 128 to support the first extension table 104 from the ground surface 128 when the fourth frame

extension member 192 is in the unstowed position. The support wheel 164 advantageously provides additional support for the extension tables.

In the twelfth embodiment of the load bed extension module 102, as shown in FIG. 40, the first support wheel 164 provides a sole support for a first side 124 of the base module 112 from the ground surface 128 to permit the agricultural bale accumulator 100 to be transported across the ground surface 128 when the first extension table 104 is in the stowed position and when the fourth frame extension member 192 is in the stowed position. The first support wheel 164 provides the sole support for the first side of the base module 112 and the first extension table 104 from the ground surface 128 to permit the agricultural bale accumulator 100 to be transported across the ground surface 128 when the first extension table 104 is the unstowed position and when the first extension table 104 is in the unstowed position and when the fourth frame extension member 192 is in the unstowed position. In this embodiment, the main wheels 108 and 110 on the bale accumulator 100 are eliminated. Preferably, the frame attachment mechanism 218 telescopes from the main frame along the pivot axis 146 to provide support for the extension tables when the load bed 113 moves to at least one of the bale accumulating position and the bale discharging position as well as the sole support for the one side of the base module 112 when the frame attachment mechanism 218 moves to the stowed position.

In the fourth, sixth, seventh, and eleventh embodiments of the load bed extension module 102, as shown in FIGs. 26 and 27, 30 and 31, 32 and 33, and 39, respectively, the agricultural bale accumulator 100 further comprises a first wheel 108 and a second wheel 110 coupled to the main frame. The first wheel 108 and the second wheel 110 contact the ground surface 128 to support the base module 112 from the ground surface 128 and to permit the agricultural bale accumulator 100 to be transported across the ground surface 128 when the first extension table 104 is in the stowed position and the unstowed position and when the fourth frame extension member 192 is in the stowed position and the unstowed position. The first support wheel 164 contacts the ground surface 128 to support the first extension table 104 from the ground surface 128 when the first extension table 104 is the unstowed position and when the fourth frame extension member 192 is in the unstowed position. The first wheel 108, the second wheel 110 and the first support wheel 164 share a common axis of rotation 134 when the fourth frame extension member 192 is in at least the unstowed position. Preferably, the frame attachment mechanism 218 telescopes from the main frame along the pivot axis 146 to provide support for the extension tables when the load bed 113 moves to at least one of the bale accumulating position and the bale discharging position as well as the additional support for the one side of the base module 112 when the frame attachment mechanism 218 moves to the stowed position.

C. Load Bed Alignment Mechanism

In the first and second embodiments of the load bed extension module 102, as shown in FIGs. 1-10 and 11-23, respectively, the agricultural bale accumulator further comprises an alignment mechanism 206 for aligning the portion 116 and 118 of the load bed 113 with the main frame 120 when the portion 116 and 118 of the load bed 113 moves from the bale discharging position to the bale accumulating position.

In the first embodiment of the load bed extension module 102, as shown in FIGs. 1-10, the alignment mechanism 206 includes first and second alignment members, in the shape of an inverted "V", connected to the main frame 120 and the portion 116 and 118 of the load bed 113, respectively, on a front side 117 of the bale accumulator 100. The first alignment member cooperatively engages the second alignment member to align the portion 116 and 118 of the load bed 113 with the main frame 120 when the portion 116 and 118 of the load bed 113 is in the bale accumulating position. The first alignment member cooperatively disengages the second alignment member when the portion 116 and 118 of the load bed 113 is in the bale discharging position.

In the second embodiment of the load bed extension module 102, as shown in FIGs. 11-23, the alignment mechanism 206 includes two guide posts attached to the fixed frame member of the third frame extension member 154. The guide posts are positioned to fall between a side of the load bed 113 and the extension table to channel the load into a home position on the main frame 120 when the load bed is returning from the bale discharging position to the bale accumulating position.

The alignment mechanism 206 reduces the strain on the pivot point 188 when the load bed 113 moves between the bale discharging position to the bale accumulating position. Under new design considerations the alignment mechanism 206 may not be necessary if heavy duty construction materials are used, especially on the pivot point 188 and the load bed 113.

D. Load Bed Latch Mechanism

In the second embodiment of the load bed extension module 102, as shown in FIGs. 11-23, the agricultural bale accumulator further comprises a latch mechanism 208 for latching the portion 116 and 118 of the load bed 113 to the main frame 120 when the portion 116 and 118 of the load bed 113 is in the bale accumulating position and for unlatching the portion 116 and 118 of the load bed 113 from the main frame 120 when the portion 116 and 118 of the load bed 113 is in the bale discharging position.

The latch mechanism 208 advantageously secures the portion 116 and 118 of the load bed 113 to the main frame 120 when the extension tables have bales accumulated thereon. Without the latch mechanism 208, the weight of the bales on one side of the portion 116 and 118 of the load bed 113 could cause the front end of the portion 116 and 118 of the load bed 113 on the other side of the portion 116 and 118 of the load bed 113 to twist in an upward direction away from the main frame 120. Under new design considerations the latch mechanism 208 may not be necessary if heavy duty construction materials are used, especially on the pivot point 188 and the load bed 113.

In the second embodiment of the load bed extension module 102, the latch mechanism 208 is shown in shown in FIGs. 13, 15, 16 and 18. The latch mechanism 208 includes a hook member, connected to a front end of the main frame 120 and a bar member, adapted to engage the hook member and attached to a front side of the right side portion 116 of the load bed 113. A control bar is connected between the hook member and the hydraulic cylinder 190 which is used for tilting the portion 116 and 118 of the load bed 113. When the hydraulic cylinder 190 begins to

cause the portion 116 and 118 of the load bed 113 to move to the bale discharging position, an end of the hydraulic cylinder 190 moves along a slot formed in the main frame 120 where the hydraulic cylinder 190 is attached. Such movement, pulls the control bar to cause the latch to disengage the bar member thereby permitting the hydraulic cylinder 190 to pivot the portion 116 and 118 of the load bed 113 to the bale discharging position. When the portion 116 and 118 of the load bed 113 returns to the bale accumulating position from the bale discharging position, the hydraulic cylinder move the opposite direction to cause the hook member to engage the bar member thereby securing the portion 116 and 118 of the load bed 113 to the main frame 120.

E. Bale Position Sensors

In the first and second embodiment of the load bed extension module 102, as shown in FIGs. 1-10 and 11-23, respectively, each of the first 104 and second 106 extension tables include bale position sensors 176 and 178, respectively, for sensing bales disposed on each of the first 104 and second 106 extension tables, respectively. Bale position sensors 170, 172 and 174 are also located on the center table 114, right table 116 and left table 118 of load bed 113, respectively.

F. Multiple Extension Tables

In the third through twelfth embodiments of the load bed extension module 102, as shown in FIGs. 24-41, the agricultural bale accumulator further comprises a third extension table 105, a third extension table attachment mechanism 125 and a third extension table support system. The third extension table attachment mechanism 125 is connected to the third extension table 105 and the first extension table 104 to permit the third extension table 105 to be moveable with the first extension table 104 relative to the base module 112 when the first extension table 104 moves between the stowed position and the unstowed position. The third extension table 105 is moveable between a stowed position and an unstowed position relative to the first extension table 104. The third extension table 105 is substantially co-planar with the load bed 113 and the first extension table 104 and adjacent to the first extension table 104 when the first extension table 104 and the third extension table 105 are each in their unstowed positions to permit the third extension table 105 to accumulate thereon at least one of the plurality of bales.

The third extension table support system connects at least one of the base module 112, the first extension table 104 and the third extension table 105. The third extension table support system contacts the third extension table 105 at a location beyond the first extension table 104 and contacts at least one of the base module 112, the first extension table 104 and the ground surface 128 to support the third extension table 105 from at least one of the base module 112, the first extension table 104 and the ground surface 128, respectively, when the first extension table 104 and the third extension table 105 are each in their unstowed positions.

In the tenth embodiment of the load bed extension module 102, as shown in FIGs. 38, the first extension table attachment mechanism further comprises a first hinge 122 for pivotally connecting the first extension table 104 to the base module 112, at the load bed 113, about a first hinge axis 136. The third extension table attachment mechanism further comprises a third hinge 125 for pivotally connecting the third extension table 105 to the first extension table 104 about a

third hinge axis 137. The first extension table 104 pivots upwards towards the base module 112 about the first hinge axis 136 when the first extension table is in the stowed position. The third extension table 105 pivots upwards towards the base module 112 and the first extension table 104 about the third hinge axis 137 when the third extension table 105 is in the stowed position. This embodiment advantageously permits the first 104 and third 105 extension tables to fold up on top of the load bed 113.

In the eleventh embodiment of the load bed extension module 102, as shown in FIGs. 39, the first extension table attachment mechanism further comprises a first hinge 122 for pivotally connecting the first extension table 104 to the base module about a first hinge axis 136. The third extension table attachment mechanism further comprises a third hinge 125 for pivotally connecting the third extension table 105 to the first extension table 104 about a third hinge axis 137. The first extension table 105 pivots upwards towards the base module 112 about the first hinge axis 136 when the first extension table 104 is in the stowed position. The third extension table 105 pivots downwards towards the base module 112 and the first extension table 104 about the third hinge axis 137 when the third extension table 105 is in the stowed position. This embodiment advantageously permits the first 104 and third 105 extension tables to collapse in an accordion fashion next to the side of the load bed.

In the twelfth embodiment of the load bed extension module 102, as shown in FIGs. 40, the first extension table attachment mechanism further a first telescoping mechanism 220 for telescopically connecting a proximal end of the first extension table 104 to the base module 112 along a horizontal axis relative to the base module 112. The third extension table attachment mechanism further comprises a first telescoping mechanism 220 for telescopically connecting a proximal end of the third extension table 105 to a distal end of the first extension table 104 along the horizontal axis relative to the base module 112. The first extension table 104 telescopes along the horizontal axis to a first position substantially inside the base module 112 when the first extension table 104 is in the stowed position. The third extension table 105 telescopes along the horizontal axis to a first position substantially inside the first extension table 104 when the third extension table 104 is in the stowed position. The first extension table 104 telescopes along the horizontal axis to a second position substantially outside the base module 112 when the first extension table 104 is in the unstowed position. The third extension table 105 telescopes along the horizontal axis to a second position substantially outside the first extension table 104 when the third extension table 105 is in the unstowed position. This embodiment advantageously permits the first 104 and third 105 extension tables to collapse inside or underneath the load bed 113.

In the twelfth embodiment of the load bed extension module 102, as shown in FIGs. 40, a top surface of the first extension table 104 is lower than a top surface of the load bed 113 by a first predetermined distance 204 when the first extension table 104 is in the unstowed position. A top surface of the third extension table 105 is lower than the top surface of the first extension table 104 by a second predetermined distance 204 when the third extension table 105 is in the unstowed position. This embodiment advantageously permits bales dispose on the first 104 and third 105 extension tables from sliding back toward the center of the bale accumulator 100.

In the eleventh and twelfth embodiment of the load bed extension module 102, as shown in FIGs. 39 and 40, the moveable frame member of the fourth frame extension member 192 is connected to the third extension table 105 to move the first 104 and third 105 extension tables between their stowed and unstowed positions in cooperation with the moveable frame member of the fourth frame extension member 192 its stowed and unstowed positions. In FIG. 39 a bias spring causes the first 104 and third 105 extension tables to pop upward about the hinge axis 225. Spacers support the tables on the moveable frame member of the fourth frame extension member 192.

G. Modular Attachment/Detachment

Preferably, the load bed extension module 102 of the present invention is attachable to and detachable from the base module 112 as a modular unit independently of any other module on the agricultural bale accumulator 100. In each of the first and second embodiments of the load bed extension module 102, as shown in FIGs. 1-23, the load bed extension module 102 is adapted to a bale accumulator Model 1030, manufactured by Hoelscher, Inc., 312 S. Main, P.O Box 195, Bushton, Kansas, U.S.A., 67427. With a modular construction, conventional bale accumulators presently used in the field may be upgraded with the load bed extension module 102 to increase the bale carrying capacity of the conventional bale accumulators. Alternatively, the modular construction of the load bed extension module 102 may offered as an option on newly manufactured bale accumulators to vary the bale carrying capacity of the bale accumulator according to the desires of the manufacturer, wholesaler, retailer or purchaser of the bale accumulator.

While the preferred embodiments describe a modular construction for the load bed extension module 102, the present invention is not limited to only a modular construction. The load bed extension module 102 may also be incorporated in to mechanical designs for bale accumulators such that it is not possible, difficult or inconvenient to detach the load bed extension module 102 from the base module 112.

H. Combination of Extension Table Support Systems

FIG. 42 illustrates a table 212 having thirty six embodiments of the extension table support system 130 for a load bed extension module for use on and/or off a pivot axis for one or more extension tables. The twelve embodiments of the load bed extension module 102 are represented as individual combinations in the table 212. The table 212 shows each of the five embodiments for extension table support system 130 along each side of the table plus one category on each side indicating no support for an extension table. In the first and second embodiments of the load bed extension module 102, the table 212 is applied to one extension table disposed on a side of the base module 112. In the third through twelfth embodiments of the load bed extension module 102, the table 212 is applied to more than one extension table disposed on a side of the base module 112. In all twelve embodiments of the load bed extension module 102, the table 212 is applied to on and/or off a pivot axis. Thus, from the combinations in the table 212 and from the preferred embodiments described hereinabove numerous design alternatives can be achieved without departing from the spirit and scope of the present invention.

VI. Bale Stacking Module

FIGs. 43-73 illustrate a bale stacking module 332. FIGs. 43-61 illustrate a bale stacking method and apparatus, using a single load bed, that raises the bales above the load bed, lowers the bales below the load bed, or raises and/or lowers bales to form a stack of bales on the load bed. FIGs. 62-73 illustrate a bale stacking method and apparatus using multiple load beds that are either moveable or fixed relative to each other, wherein the accumulator 100 discharges the bales from the load bed to a ground surface either simultaneously to form stacks of bales on the ground surface or sequentially to form a single layer of bales on the ground surface.

A. Bale Stacking Method and Apparatus - Single Load Bed

FIG. 43 illustrates a flowchart 232 describing a first general bale stacking method 230-240 for forming and accumulating stacks of bales on a load bed of an agricultural bale accumulator and for discharging the stacks of bales to a ground surface.

1. Bale Raising Method

a. Bale Raising Method

FIG. 44 illustrates a flowchart 243 describing a first particular bale stacking method 242-266 for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by raising the bales above the load bed to form a stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

b. First Bale Handling Sequence - Raise,/Transfer

FIG. 45 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 270-300 responsive to the first particular bale stacking method described in FIG. 44 to accumulate the stacks of bales on the load bed.

c. Second Bale Handling Sequence - Transfer/Raise

FIG. 46 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 302-330 responsive to an alternate embodiment of the first particular bale stacking method described in FIG. 44 to accumulate the stacks of bales on the load bed by transferring the bales across the load bed then raising the bales above the load bed to form the stack of bales.

3. Bale Raising Apparatus

a. First Bale Raising Apparatus - Moveable Frame

FIG. 47 illustrates, in a right side elevation view, an agricultural bale accumulator having a first embodiment of a bale stacking module 332 for raising the bales above a load bed responsive to the first particular bale stacking method described in FIG. 44 and the sequence of bale handling operations shown in FIG. 45. FIG. 48 illustrates, in a top side plan view, the agricultural bale accumulator having the first embodiment of the bale stacking module shown in FIG. 47.

FIG. 49 illustrates, in a rear side elevation view, the agricultural bale accumulator having the first embodiment of the bale stacking module shown in FIGs. 47 and 48.

These figures first disclose: a recessed bale raising mechanism 334, a bale raising pad 336, a bale raising support arm 338, a bale engaging fork 340, a bale raising pad pivot 342, a bale

raising support arm pivot 344, a bale raising support frame (H-frame) 346, a bale raising hydraulic cylinder 348, a pad receiving holes in center load bed 350, a support arm guide 352, a bale raising distance 354, a support frame moving distance 356, a hydraulic cylinder movement 358, a lateral load bed bale guide 360, a bale raising pad hinge 362, a recessed bale raising mechanism 334, a bale raising pad 336, a bale raising support arm 338, a bale engaging fork 340, a bale raising pad pivot 342, a bale raising support arm pivot 344, a bale raising support frame (h-frame) 346, a bale raising hydraulic cylinder 348, a pad receiving holes in center load bed 350, a support arm guide 352, a bale raising distance 354, a support frame moving distance 356, a hydraulic cylinder movement 358, a lateral load bed bale guide 360 and a bale raising pad hinge 362.

b. Second Bale Raising Apparatus - Fixed Frame

FIG. 50 illustrates, in a rear side elevation view, an agricultural bale accumulator having a second embodiment of a bale stacking module for raising bales above the load bed responsive to the first particular bale stacking method described in FIGs. 44 and the sequence of bale handling operations shown in FIG. 45. FIG. 51 illustrates, in a top side plan view, the agricultural bale accumulator having the second embodiment of the bale stacking module shown in FIG. 52.

This figure first discloses: a fixed bale raising mechanism 364, a bale raising cam 366, a cam follower 368, a cam gate 370 and a fixed bale raising frame 372.

4. Bale Lowering Method and Apparatus

a. Bale Lowering Method

FIG. 52 illustrates a flowchart 375 describing a second particular bale stacking method 374-394 for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by lowering the bales below the load bed to form a stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

b. Bale Handling Sequence - Lower,/Transfer

FIG. 53 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 400-444 responsive to the second particular bale stacking method described in FIG. 52 to accumulate the stacks of bales on the load bed.

c. Bale Lowering Apparatus - Lowering Center Load Bed

FIG. 54 illustrates, in a rear side elevation view, an agricultural bale accumulator having a third embodiment of a bale stacking module for lowering the bales below a load bed responsive to the second particular bale stacking method described in FIG. 52 and the sequence of bale handling operations shown in FIG. 53, wherein a bale receiving portion of the load bed is located in a bale lowering position. FIG. 55 illustrates, in a rear side elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking module shown in FIG. 54, wherein the bale receiving portion of the load bed is located in a bale receiving position. FIG. 56 illustrates, in a right side elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking module shown in FIGs. 54 and 55, wherein the bale receiving portion of the load bed is located in the bale receiving position. FIG. 57 illustrates, in a right side

elevation view, the agricultural bale accumulator having the third embodiment of a bale stacking module shown in FIGs. 54 ,55 and 56, wherein the bale receiving portion of the load bed is located in the bale lowering position. FIG. 58 illustrates, in a top side plan view, the agricultural bale accumulator having the third embodiment of a bale stacking module shown in FIGs. 54 ,55, 56 and 57, wherein the bale receiving portion of the load bed is located in the bale receiving position.

These figures first disclose: a bale lowering mechanism 446, a scissors mechanism 448, scissors cam 450, a bale lowering hydraulic cylinder 452, a retractable bale support member 454, a bale support member pocket 456, a retractable bale support guide 458, a guide hinge 460

5. Bale Raising/Lowering Combination Method and Apparatus

a. Bale Raising/Lowering Combination Method

FIG. 59 illustrates a flowchart 263 describing a third particular bale stacking method 462-508 for performing the first general bale stacking method described in FIG. 43 for forming and accumulating the stacks of bales on the load bed, by raising and/or lowering the bales above and/or below the load bed, respectively, to form the stack of bales then transferring the stack of bales across the load bed, and for discharging the stacks of bales to the ground surface.

b. Bale Handling Sequence - Raising/Lowering/Transfer

FIG. 60 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 510-558 responsive to the third particular bale stacking method described in FIG. 59 and using the second embodiment of a bale stacking module shown in FIGs. 50 and 51 in combination with the third embodiment of a bale stacking module shown in FIGs. 54-58 to accumulate the stacks of bales on the load bed, wherein a first received bale is raised above the load bed and a second received bale is lowered below the load bed.

c. Bale Handling Sequence - Lowering/Raising/Transfer

FIG. 61 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 560-608 responsive to the third particular bale stacking method described in FIG. 59 and using the second embodiment of a bale stacking module shown in FIGs. 50 and 51 in combination with the third embodiment of a bale stacking module shown in FIGs. 54-58 to accumulate the stacks of bales on the load bed, wherein a first received bale is lowered below the load bed and a second received bale is raised above the load bed.

d. Bale Raising/Lowering Combination Apparatus

The combination apparatus is not illustrated, but is constructed from a combination of the separate bale raising and bale lower apparatus to produce the resulting combination apparatus.

B. Bale Stacking Method And Apparatus - Multiple Load Beds

FIG. 62 illustrates a flowchart 611 describing a second general bale stacking method 610-622 for accumulating bales on a plurality of load beds of an agricultural bale accumulator which are disposed parallel to and vertically displaced relative to each other along a common vertical load

bed axis and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

1. Moveable Load Bed Method And Apparatus

a. Moveable Load Bed Method

FIG. 63 illustrates a flowchart 623 describing a first particular bale stacking method 624-654 for performing the second general bale stacking method described in FIG. 62 for accumulating the bales on the plurality of load beds, by accumulating the bales on a first load bed, moving the first load bed above a second load bed, then accumulating the bales on the second load bed, and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

b. Bale Handling Sequence - Fill/Raise Load Bed

FIG. 64 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 656-682 responsive to the first particular bale stacking method described in FIG. 63 to accumulate the bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales.

c. First Moveable Load Bed Apparatus - Stacked Load Beds

FIGs. 65 and 66 illustrate, in a rear side elevation view and a top side plan view, respectively, an agricultural bale accumulator having a first embodiment of the bale stacking module for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales responsive to the first particular bale stacking method described in FIG. 63 and the sequence of bale handling operations shown in FIG. 64.

These figures first disclose: a moving load bed mechanism 684, a bale sensor pad opening 686, a bale transfer module opening 688, a lateral bale advancement apparatus 690, a table raising hydraulic cylinder 692, a fixed guide post 694 and a movable load bed 696.

d. Second Moveable Load Bed Apparatus - Nested Load Beds

FIGs. 67 and 68 illustrate, in a rear side elevation view and a top side plan view, respectively, an agricultural bale accumulator having a second embodiment of the bale stacking module for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales or a single layer of bales responsive to the first particular bale stacking method described in FIG. 63 and the sequence of bale handling operations shown in FIG. 64.

These figures first disclose: a nested bale moving load bed 698, a movable load bed slats 700, a fixed load bed slats 702, a movable load bed frame 704.

2. Fixed Load Bed Method And Apparatus

a. Fixed Load Bed Method

FIG. 69 illustrates a flowchart 707 describing a second particular bale stacking method 706-736 for performing the second general bale stacking method described in FIG. 62 for accumulating the bales on the plurality of load beds, by accumulating the bales on a first load bed

and a second load bed located at a fixed position above the first load bed, and for discharging the accumulated bales to a ground surface to form stacks of bales.

b. Bale Handling Sequence - Fill Lower/Upper Load Bed

FIG. 70 illustrates, in a rear side elevation view, an agricultural bale accumulator performing a sequence of bale handling operations 738-778 responsive to the second particular bale stacking method described in FIG. 69 to accumulate the bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales.

c. Fixed Load Bed Apparatus

FIG. 71 illustrates, in a rear side elevation view, an agricultural bale accumulator having an embodiment of the bale stacking module for accumulating bales on the plurality of load beds and for discharging the accumulated bales to a ground surface to form stacks of bales responsive to the second particular bale stacking method described in FIG. 69 and the sequence of bale handling operations shown in FIG. 70, wherein a bale receiving portion of the load bed is in a bale receiving position. This figure first discloses: a fixed load bed mechanism 780 and a fixed load bed 782. FIG. 72 illustrates, in a rear side elevation view, the agricultural bale accumulator having the embodiment of the bale stacking module shown in FIG. 71, wherein the bale receiving portion of the load bed is in a bale elevating position. FIG. 73 illustrates, in a top side plan view, the agricultural bale accumulator having the embodiment of the bale stacking module shown in FIGs. 71 and 72, wherein a bale receiving portion of the load bed is in a bale receiving position.

VII. Bale Advancement Module

FIGs. 74-80 illustrate a bale advancement module 798, including a method which is performed by one of a first apparatus, formed as a spiked cylinder, and a second apparatus, formed as a spiked conveyor.

A. Bale Advancement Method

FIG. 74 illustrates a flowchart 785 describing a bale advancement method for advancing bales on a load bed 113 of an agricultural bale accumulator 100. The method starts at step 784.

At step 786, a plurality of bales, including a first bale 801 followed by a second bale 803, are received on the load bed 113 at a first rate of speed 802 along a bale receiving axis 201. The bale advancement method is particularly beneficial when the bales are successively and directly received from a baler 101 as described herein. However, the bale advancement method may also be used when the bales are not successively and directly received from a baler 101, such as when the bales are picked up from a ground surface.

Next, at step 788, a determination is made whether the first bale 801 is located at a first predetermined position on the load bed 113 along the bale receiving axis 201 responsive to the receipt of the first bale 801 on the load bed 113. If the determination at step 788 is negative, then the method returns to step 786 to continue to receive the first bale 801 on the load bed 113. If the determination at step 788 is positive, then the flowchart continues to step 790. In particular, step 788 monitors the formation of and the ejection of the first bale 801 from a bale chamber of the baler 101. When the first bale 801 is located at the first predetermined position on the load bed 113, the first bale 801 is completely formed, tied, ejected from the bale chamber of the baler 101

and, preferably, clear of the bale chute 103 to permit the first bale 801 to be advanced without any type of friction or interference from the baler 101.

Continuing at step 790, the first bale 801 is advanced onto the load bed 113 at a second rate of speed 804, greater than the first rate of speed 801, along the bale receiving axis 201 responsive to the determination at step 788 that the first bale 801 is located at the first predetermined position along the bale receiving axis 201 to advance the first bale 801 ahead of the second bale 803 by a predetermined distance 808 along the bale receiving axis 201.

Next, at step 792, a determination is made whether the first bale 801 is located at a second predetermined position along the bale receiving axis ahead of the first predetermined position along the bale receiving axis 201 by the predetermined distance 808 responsive to the advancement of the first bale 801 onto the load bed 113 along the bale receiving axis 201 at step 790. If the determination at step 792 is negative, then the flowchart returns to step 790 to continue to advance the first bale 801 on the load bed 113. If the determination at step 792 is positive, then the flowchart continues to step 794 to continue to stop the advancement of the first bale 801 on the load bed 113.

After step 794, at step 796, the first bale 801 received on the load bed 113 is handled in a first amount of time less than a second amount of time required for the second bale 803 to move through the predetermined distance 808 at the first rate of speed 802 along the bale receiving axis 201 responsive to the advancement of the first bale 801 onto the load bed 113 along the bale receiving axis 201. In particular, the first bale 801 received on the load bed 113 is handled responsive to the determination that the first bale 801 is located at the second predetermined position on the load bed 113. After step 796, the method returns to step 786 to continue to receive a new first bale 801 on the load bed 113.

At step 796, the first bale 801 received on the load bed 113 may be handled to accomplish any bale handling operation including, by example and without limitation, the operation of accumulating the bales on the load bed 113 and the operation of discharging the bales from the load bed 113 to the ground surface 128, and particularly including all of the bale handling operations disclosed herein. In the preferred embodiment, the bale handling operation includes bale stacking and bale discharging operations, as described herein. In the case of the bale stacking operation, the bales or the load beds advantageously move in the first amount of time less than the second amount of time required for the second bale 802 to move through the predetermined distance 808 along the bale receiving axis 201 at the first rate of speed 802 responsive to the first bale 801 being advanced onto the load bed 113, at step 796. In the case of the bale discharging operation implemented as a pivoting load bed, the load bed advantageously moves from the bale receiving position to the bale discharging position and back to the bale receiving position in the first amount of time less than the second amount of time required for the second bale 802 to move through the predetermined distance 808 along the bale receiving axis 201 at the first rate of speed 802 responsive to the first bale 801 being advanced onto the load bed 113, at step 796.

Therefore, the bale advancement method advantageously provides the accumulator 100

with enough time to perform bale handling operations on the last received bale 801 before the next bale 802 is received on the load bed 113.

Preferably, at least one of the first predetermined position and the second predetermined position, determined to be reached by the first bale 801, along the bale receiving axis 201 is adjustable. This adjustment optimizes the predetermined distance 808, created between the first bale 801 and the second bale 803, for various bale lengths, distances between the front side 117 of the accumulator 100 and either the baler 101 or the bale chute 103, various bale traveling speeds, various crop conditions, such as type, weight, moisture content, etc., various bale handling operations, such as different bale accumulation arrangements and bale discharging operations, etc., and the like. The adjustment may be perform manually by a person, such as an operator, distributor, or a manufacturer of the accumulator 100, and/or may be performed automatically under control of the tractor, baler 101, the accumulator 100, or the like. Manual adjustment is advantageous to accommodate the various bale lengths and various distances between the front side 117 of the accumulator 100 and either the baler 101 or the bale chute 103. Automatic adjustment is advantageous to accommodate, in real time during the operation of the accumulator 100, the various bale traveling speeds, various crop conditions, such as type, weight, moisture content, etc., various bale handling operations, such as different bale accumulation arrangements and bale discharging operations, etc., and the like.

B. Bale Advancement Apparatus

FIGs. 75, 76 and 77 illustrate, each in a right side elevation view, an agricultural bale accumulator having a first embodiment of a bale advancement module performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74. FIGs. 78, 79 and 80 illustrate, each in a right side elevation view, an agricultural bale accumulator having a second embodiment of a bale advancement module performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74. Referring to FIGs. 75-80, a load bed 113 is adapted to receive thereon a plurality of bales, including a first bale 801 followed by a second bale 803, at a first rate of speed 802 along a bale receiving axis 201.

A first bale position sensor 168 determines that the first bale 801 is located at a first predetermined position on the load bed 113 along the bale receiving axis 201 responsive to receiving the first bale 801 on the load bed 113. Generally, the first bale position sensor 168 comprises a bale position monitoring mechanism adapted to monitor the formation of and the ejection of the first bale 801 from the bale chamber of the baler 101. In the preferred embodiment, the first bale position sensor 168 is implemented as a sensing plate located at the first predetermined position along the bale receiving axis 201 and moveable between a first position and a second position about a hinge axis mechanically coupling the sensing plate to the load bed 113. The sensing plate is located in the first position responsive to the first bale 801 not applying a force to the sensing plate. The sensing plate is located in the second position responsive to the first bale 801 applying a force, generated by its weight, to the sensing plate. A switch is coupled to the sensing plate and has a first switched state responsive to the sensing plate being located in the first position and a second switch state responsive to the sensing plate being located in the

second position. A first adjustment mechanism, mechanically coupled to the sensing plate and the load bed 113, permits adjustment of the first predetermined position of the first bale position sensor 168 along the bale receiving axis 201 for the reasons discussed hereinabove with reference to the bale advancement method. The first adjustment mechanism may be adjusted by physically relocating the first bale position sensor 168 along the bale receiving axis 201 within an elongated slot or recess, formed in the load bed 113, and disposed essentially parallel to the bale receiving axis 201.

A bale advancement apparatus advances the first bale 801 onto the load bed 113 at a second rate of speed 804, greater than the first rate of speed 802, along the bale receiving axis 201 responsive to the determination by the first bale position sensor 168 that the first bale 801 is located in the first predetermined position along the bale receiving axis 201 to advance the first bale 801 ahead of the second bale 803 by a predetermined distance 808 along the bale receiving axis 201.

In the preferred embodiment, the bale advancement apparatus includes a bale engaging mechanism and a bale driving mechanism. The bale engaging mechanism engages the first bale 801. The bale driving mechanism is coupled to the bale engaging mechanism and causes the bale engaging mechanism to engage the first bale 801 and to drive the bale engaging mechanism to advance the first bale 801 ahead of the second bale 803 by the predetermined distance 808 along the bale receiving axis 201. The bale driving mechanism may any drive mechanism including, hydraulic or electric. The bale driving mechanism may be driven either continuously or periodically, wherein each periodic drive of the bale driving mechanism advances the first bale 801 a subdistance within the predetermined distance 808.

The bale engaging mechanism includes projections 805 and a projection support surface 807. The projections 805 protrude at least partially into the first bale 801 when engaging the first bale 801. The projections 805 have an appropriate length and shape to securely engage the first bale 801 without damaging the bale or breaking the bale twine. The projection support surface 807 is coupled to the projections 805 in such a manner that the projections 805 extend outwardly from the projection support surface 807. In the preferred embodiment, the projection support surface 807 is disposed below a bale receiving surface of the load bed 113 upon which the first bale 801 is received on the load bed and the projections 805 are permitted to extend above the bale receiving surface of the load bed 113 to protrude at least partially into the first bale 801.

Preferably, the projections 805 are disposed above the bale receiving surface of the load bed 113 to protrude at least partially into the first bale 801 to advance the first bale 801 and are disposed below the bale receiving surface of the load bed 113 when not advancing the bale so as not to interfere with any subsequent bale handling operations. In the preferred embodiment, the projections 805 are disposed at intermittent positions on the projection support surface 807 permitting the bale driving mechanism to move the bale engaging mechanism to a position such that no projections extend above the bale receiving surface of the load bed 113 and to move the bale engaging mechanism to a position such that the projections 805 extend above the bale receiving surface of the load bed 113. In other words the projection support surface 807 has a

bald spot where no projections 805 are located. With the bald spot implementation, the bale engaging mechanism periodically drives the first bale 801 due to the bald spot between the projections even though the bale drive mechanism drives the bale engaging mechanism continuously. Preferably, the bale drive mechanism stops driving the bale engagement mechanism when the bale spot on the projection support surface 807 is opposite to the bale receiving surface of the load bed 113 so that no projections above the bale receiving surface of the load bed 113. Alternatively, a retraction mechanism can retract the bale engaging mechanism or the projections 805 below the bale receiving surface of the load bed 113 by lowering the bale engaging mechanism or the projections 805. However, the bald spot embodiment is preferable to avoid the need for a retraction mechanism which would be more complicated and more costly.

A bale handling module handles the first bale 801 received on the load bed 113 in a first amount of time less than a second amount of time required for the second bale 803 to move through the predetermined distance 808 at the first rate of speed 802 along the bale receiving axis 201 responsive to the advancement of the first bale 801 onto the load bed 113 along the bale receiving axis 201. Reference number 810 represents a distance traveled by the second bale 803 while the first bale 801 is advanced onto the load bed 113. Reference number 812 represents a distance, between the bale chute 103 and the front side 117 of the load bed, over which the second bale will travel before reaching the load bed 113. The distance 812 is an important distance if the bale handling operation involves the discharge of the first bale 801 from the bale receiving portion 114 of the load bed 113, as will be described hereinbelow with reference to the permissive bale discharge module and the selective bale discharge control module.

The bale handling module includes any module on an accumulator including, by example and without limitation, any bale accumulation module and any bale discharge module, and particularly including all of the modules disclosed herein. In the preferred embodiment, the bale handling module includes the bale stacking module and the bale discharging module, as described herein.

In the preferred embodiment, the bale advancement apparatus 798 also includes a second bale position sensor 184 that determines that the first bale 801 is located in a second predetermined position along the bale receiving axis 201. Reference number 810 represents a distance between the first bale position sensor 168 and the second bale position sensor 184 on the bale receiving surface 114 of the load bed 113 when each of the two sensor are implemented as sensing plates. The distance 810 may be greater than or less than the distance 808 created between the first bale 801 and the second bale 803. The second bale position sensor 184 is located ahead of the first predetermined position along the bale receiving axis 201, when reference to the bale traveling direction 222, by a predetermined distance 806. The bale advancement apparatus stops the advancement of the first bale 801 onto the load bed 113 along the bale receiving axis 201 responsive to the determination by the second bale position sensor 184 that the first bale 801 is located in the second predetermined position along the bale receiving axis 201. The bale handling module handles the first bale 801 responsive to the determination that the first bale 801 is located in the second predetermined position.

The second bale position sensor 184 is preferably implemented as a sensing plate like the sensing plate described hereinabove with the first bale position sensor 168. Preferably, the second bale position sensor 184 is be the same bale position sensor that is used to determine when to discharge the bales from the load bed to the ground surface. In this case, the accumulator 100 performs any bale handling operations before the bale discharge operation when the accumulator is ready to discharge the bales from the load bed 113. Alternatively, the second bale position sensor 184 may be a separate sensor.

As an alternative to the sensing plate implementation, the second bale position sensor 184 may be implemented with the bale drive mechanism. In this case the bale drive mechanism drive the bale engagement mechanism by a known drive amount to advance the first bale 801 by the predetermined distance 808. This implementation is attractive because a separate device, such as a sensing plate, is not needed. However, intelligent control of the bale drive mechanism is needed to drive the first bale 801 for an appropriate amount of time to create the predetermined distance 808.

A second adjustment mechanism, mechanically coupled to the second bale position sensor 184 and the load bed 113, permits manual or automatic adjustment of the second predetermined position along the bale receiving axis 201 for the same reasons discussed hereinabove with the bale advancement method. The second adjustment mechanism may be adjusted by physically relocating the second bale position sensor 184 along the bale receiving axis 201 within an elongated slot or recess, formed in the load bed 113, and disposed essentially parallel to the bale receiving axis 201.

Although the bale advancement apparatus is described for the purpose of advancing bales onto the load bed 113 along bale receiving axis 201 substantially parallel to the longitudinal axis of the load bed 113, the bale advancement apparatus may also be used to transfer bales across the load bed along a bale transfer axis substantially transverse to the bale receiving axis and essentially parallel to the lateral axis of the load bed 113. This lateral bale advancement apparatus 690 may be considered as an alternative bale transfer module, implemented as the push bar 186. The lateral bale advancement apparatus 690 is illustrated in FIGs. 65, 66, 67 and 68 as a bale transfer mechanism to laterally transfer the bales from the load bed onto a load bed extension table when the bale stacking apparatus having two load beds is used. The lateral bale advancement apparatus 690 is advantageously used in FIGs. 65, 66, 67 and 68 to advance the bales past the posts supporting the moveable load bed to permit the bales to be discharged from each of the load beds to the ground surface without interfering with the posts. In FIGs. 65, 66, 67 and 68, the conventional bale transfer module, implemented as the push bar 186, cannot create the needed separation between a bale located on the side of the load bed, adjacent to the load bed extension table, and a bale located on the load bed extension table.

1. First Bale Advancement Apparatus - Spiked Cylinder

In the preferred embodiment, as shown in FIGs. 75, 76 and 77 the bale engaging mechanism described hereinabove is implemented as a cylinder or a plurality of disks 800 having a circular shaped cross-section and positioned so that rotation of the cylinder causes the first bale

801 to advance ahead of the second bale 803 by the predetermined distance 808 along the bale receiving axis 201. The bale engaging mechanism, implemented as a cylinder 800, is also illustrated in FIGs. 66, 68, 130, 131 and 132. Preferably, the cylinder has an appropriate length or the disks are spaced appropriately so that the projections 805 extend into the bale across a width of the bale to permit the bale drive mechanism to drive the bale along a straight line along the bale receiving axis 201 with minimal lateral displacement.

2. Second Bale Advancement Apparatus - Spiked Conveyor

In an alternate embodiment, as shown in FIGs. 78, 79 and 80, the bale engaging mechanism described hereinabove is implemented a spiked conveyor 814 forming a closed loop and positioned so that rotation of the conveyor causes the first bale 801 to advance ahead of the second bale 803 by the predetermined distance 808 along the bale receiving axis 201. In the preferred embodiment, the conveyor is implemented as a chain. However, other types of conveyors can be used such as a belt.

VIII. Bale Arrangement Control Module

FIGs. 81-83 illustrate a bale arrangement control module 832. FIG. 81 illustrates a flowchart describing a method to be performed by an embodiment of an apparatus shown in FIG. 82 and 128 to determine a dynamic arrangement of bales on the load bed of the accumulator, as shown in FIG. 83.

A. Bale Arrangement Control Method

FIG. 81 illustrates a flowchart 830 describing a bale arrangement control method for accumulating bales on a load bed 113 of an agricultural bale accumulator 100 by varying a bale accumulation arrangement responsive to an input condition.

At step 816, the accumulator 100 starts the method. At step 818, the accumulator 100 receives an input condition. At step 820, the accumulator 100 receives a plurality of bales, formed by a baler 101. At step 822, the accumulator 100 determines a dynamic arrangement for the plurality of bales received on the accumulator 100 responsive to the input condition. At step 824, the accumulator 100 accumulates the plurality of bales received on the accumulator 100 responsive to the dynamic arrangement. At step 826, the accumulator 100 determines whether to discharge the bales accumulated on the accumulator 100 in the dynamic arrangement from the accumulator 100 to the ground surface 128. If the determination at step 826 is positive, then the method continues to step 828. At step 828, the accumulator 100 discharges the bales accumulated on the accumulator 100 in the dynamic arrangement from the accumulator 100 to the ground surface 128. If the determination at step 826 is negative, then the method continues to one of steps 818 and 820, to continue to receive bales along with a dynamic input condition and a static input condition, respectively.

In the preferred embodiment, the input condition is determined the input condition is determined during the step of receiving to provide a dynamic and real time input condition while the accumulator 100 is operating. Alternatively,. the input condition is determined the input condition is determined before the step of receiving to provide a predetermined and static input condition prior to operating the accumulator 100.

Preferably, the accumulator 100 performs the step of accumulating, at step 824, by forming at least one stack of bales, having at least two bales, along the bale stacking axis 203 responsive to receiving the plurality of bales on the load bed 113 and responsive to the determined dynamic bale arrangement to permit the accumulator 100 to accumulate the at least one stack of bales on the load bed 113, and by transferring the at least one stack of bales across the load bed 113 along the bale transfer axis 202 responsive to the at least one stack of bales being formed on the load bed 113 and responsive to the determined dynamic bale arrangement to permit the accumulator 100 to accumulate the plurality of bales on the load bed 113. Hence, the accumulator 100 can create any number of dynamic bale arrangements, in a matrix of bale arrangements, represented by a number of bales permitted to be stacked by the accumulator 100 and a number of bales permitted to be transferred across the accumulator 100 for accumulation thereon.

Generally, the input conditions includes any input condition. In a first embodiment of the bale arrangement control method, the input condition is condition of the accumulator 100. In one example of the first embodiment of the bale arrangement control method, the input condition of the accumulator 100 is a bale accumulating capacity of the accumulator 100. For example, where the accumulator 100 has a load bed extension module 102 including a extension table, the bale accumulating capacity of the accumulator 100 is responsive to the extension table being in one of the stowed position and the unstowed position. The accumulator 100 has a first bale accumulating capacity when the extension table is in the stowed position by not permitting at least one bale of the plurality of bales to be received on the extension table. The accumulator 100 has a second bale accumulating capacity, greater than the first bale accumulating capacity, when the extension table is in the unstowed position by permitting bales to be received on the extension table. Hence, the accumulator 100 dynamically changes its bale arrangement depending on the position of the extension table. In practice, for example, the accumulator 100 would confine the bale arrangement to the load bed 113, if the extension tables are moved to their stowed positions while accumulating bales near a fence row.

In another example of the first embodiment of the bale arrangement control method, the input condition of the accumulator 100 is a measure of levelness of the load bed 113 relative to a horizontal plane as determined by a load bed leveling module described hereinbelow. In this case, the accumulator 100 determines a dynamic arrangement for the plurality of bales received on the accumulator 100 responsive to the measure of levelness of the load bed relative to the horizontal plane. Hence, the accumulator 100 dynamically changes its bale arrangement depending on a measure of levelness of the load bed 113. In practice, for example, the accumulator 100 would stop stacking bales or reduce the number of bales in a stack if the load bed too far out of level.

In a second embodiment of the bale arrangement control method, the input condition is a condition of each of the plurality of bales. In one example of the second embodiment, the input condition of each of the plurality of bales is a weight of each of the plurality of bales received. Hence, the accumulator 100 dynamically changes its bale arrangement depending on the weight of each of the plurality of bales received. In practice, for example, the accumulator 100 would stop stacking bales or reduce the number of bales in a stack if the bales are determined to be too heavy.

In another example of the second embodiment of the bale arrangement control method, the input condition of each of the plurality of bales is at least one of a length, a width and a height of each of the plurality of bales received. Hence, the accumulator 100 dynamically changes its bale arrangement depending on at least one of the length, the width and the height of each of the plurality of bales received. In practice, for example, the accumulator 100 would stop stacking bales or reduce the number of bales in a stack if the bales are determined to be too big.

In a third embodiment of the bale arrangement control method, the input condition is a condition of an input signal representative of a location of the accumulator 100 in a field in which the accumulator 100 is accumulating or discharging the plurality of bales, as described hereinbelow with the field location module. In one example of the third embodiment of the bale arrangement control method, the input condition is a location of the accumulator 100 relative to predetermined bale discharge zones in the field. Hence, the accumulator 100 dynamically changes its bale arrangement depending on the location of the accumulator 100 relative to the predetermined bale discharge zones in the field. In practice, for example, the accumulator 100 would arrange the bales to provide the most compact arrangement of bales to be discharged in the bale discharge zones.

In a fourth embodiment of the bale arrangement control method, the input condition is a condition of a bale carrying capacity of a bale hauling truck which is adapted to haul the plurality of bales accumulated by the accumulator 100 to a remote site. In this case, some bale hauling vehicles, such as semi trailers can carry big rectangular bales stacked two bales high and others can carry bales stacked three bales high depending on the height of the trailer, the height of the bales forming the stack of bales and the weight of the bales, in order to meet the height and weight limits of the trailer for safe roadway travel. Hence, the accumulator 100 dynamically changes its bale arrangement depending on the bale accumulating capacity of a bale hauling truck. In practice, for example, the accumulator 100 would arrange the bales to be accumulated and discharged in an arrangement to minimize the time for a loader to load the bale hauling truck while providing the most efficient hauling capacity, within legal limits, for the bale hauling truck.

In a fifth embodiment of the bale arrangement control method, the input condition is a condition of a bale storing capacity of a remote site adapted to store the plurality of bales accumulated by the accumulator 100. In this case, some storage facilities, such as barns can store big rectangular bales stacked in multiples of two bales high and others can carry bales stacked in multiples of three bales high depending on the height of the storage facility, the height of the bales forming the stack of bales and the weight of the bales, in order to provide for safe and efficient storage of the bales. Hence, the accumulator 100 dynamically changes its bale arrangement depending on the bale storing capacity of a remote site. In practice, for example, the accumulator 100 would arrange the bales to be accumulated and discharged in an arrangement to minimize the time for a loader to store the bales while providing safe and efficient storage of the bales.

In a sixth embodiment of the bale arrangement control method, the input condition is a condition of a manual input signal provided by an operator of the accumulator 100. In this case,

the operator can dynamically changes its bale arrangement depending on conditions desirable to the operator and which conditions may be undetermined by the accumulator 100.

B. Bale Arrangement Control Apparatus

FIG. 82 illustrates, in a rear side elevation view, an accumulator 100 having a load bed extension module 102, including four extension tables 104-107, having a bale stacking module 332 and having a bale arrangement control module 830 for controlling the bale accumulation arrangement responsive to the bale arrangement control method described in FIG. 81. The accumulator 100 represented in FIG. 82 is a simplified representation of the accumulator 100 illustrated in FIGs. 129-132, described hereinbelow. The accumulator 100 in FIG. 82 is shown to have a maximum bale accumulating capacity of twenty one bales. At its maximum bale accumulating capacity, the accumulator 100 can carry three bales high, formed by the bale stacking module 332, along the bale stacking axis 203 and can carry seven bales wide, formed by the bale transfer module 186, along the bale transferring axis 202. Hence the bale arrangement apparatus comprises the various apparatus, including, without limitation, the bale stacking and bale transfer apparatus, needed to accumulate the bales on the accumulator 100 in the dynamic bale arrangement.

FIG. 83 illustrates a table 832 showing a plurality of bale arrangements capable of being produced by the bale arrangement control module 830 responsive to the bale arrangement control method described in FIG. 81 for the accumulator 100 shown in FIG. 82. Preferably, the dynamic bale arrangement is a matrix arrangement represented by a first number of bales 834 disposed along the bale transfer axis 202 horizontally transverse to the bale receiving axis 201 and by a second number of bales 836 disposed along the bale stacking axis 203 vertically transverse to the bale receiving axis and the bale transfer axis 202. The table 832 shows the horizontal bale accumulating capacity being seven bales and shows the vertical bale accumulating capacity being three bales to provide a maximum bale accumulating capacity of twenty one bales for accumulation by the accumulator 100 illustrated in FIG. 83. Hence, the table 832 shows twenty one dynamic bale arrangements available to the accumulator 100 illustrated in FIG. 83.

Note that the entries in the table 832, indicating a bale number, do not imply the order in which the bales are accumulated on the accumulator 100 illustrated in FIG. 83. However, the entries in the table 832, indicating the bale number, do correspond to the location of the bales on the accumulator 100 illustrated in FIG. 83 for the particular bale arrangement. For example, if bale arrangement control module 830 determines that a bale arrangement of three bales wide by one bale wide is desired, then bales numbered fifteen, twenty one and eighteen will be accumulated on the left 118, center 114 and right 116 portions of the load bed 113, respectively.

The dynamic bale arrangements range from one bale (i.e. one horizontally accumulated bale by one vertically accumulated bale) to twenty one bales (i.e. seven horizontally accumulated bale by three vertically accumulated bale). The table 832 notes at the table entry, corresponding to three bales high by three bales wide, that the load bed 113 is filled to its maximum bale accumulating capacity. The table 832 also notes at the table entry, corresponding to three bales high by seven bales wide, that the load bed 113 and the load bed extension module 102, including

the four extension tables 104-107, forming the entire bale accumulating surface of the accumulator 100 are filled to their maximum bale accumulating capacity.

Although the dynamic bale arrangement is represented as a matrix of bales herein, the bale arrangement control module 830 is not limited to this particular arrangement. The bale arrangement control module 830 can arrange the bales along one axis, two axes or three axes, as desired. Further, the accumulator 100 shown in FIG. 82 and the table 832 in FIG. 83 are provided for an example only and any other accumulator and any other table having dynamic bale arrangements corresponding to the other accumulator may incorporate the bale arrangement control module 830.

IX. Bale Stabilization Module

FIGs. 84-103 illustrate a bale stabilization module 899. FIGs. 84-91 illustrate a load bed leveling module 900. FIGs. 84, 92-103 illustrate a lateral bale stabilization module 966. FIG. 84 illustrates a flowchart 839 describing a general stabilization method for stabilizing bales accumulated on a load bed of an agricultural bale accumulator.

In FIG. 84, at step 838, the method starts.

Next, at step 840, a plurality of bales are received on a load bed along a bale receiving axis. The load bed forms a part of a base module of the accumulator adapted to be supported by and transported across a ground surface. The ground surface has a degree of levelness, relative to a horizontal plane, which varies across the ground surface. The load bed is substantially planar and has a measure of levelness, relative to the horizontal plane, which varies in accordance with the degree of levelness as the agricultural bale accumulator is transported across the ground surface.

Next, at step 842, the plurality of bales are accumulated on the load bed at predetermined positions on the load bed responsive to the step of receiving as the agricultural bale accumulator is transported across the ground surface. An undesirable amount of the measure of levelness of the load bed encourages the plurality of bales located at the predetermined positions on the load bed to move from the predetermined positions as the accumulator is transported across the ground surface.

Next, at step 844, the plurality of bales accumulated on the load bed are stabilized, without using a bale stabilization structure permanently disposed above a bale receiving surface of the load bed, responsive to the step of accumulating to encourage the plurality of bales accumulated on the load bed, located at the predetermined positions on the load bed, to remain located at the predetermined positions on the load bed as the agricultural bale accumulator is transported across the ground surface.

Next, at step 849, the method ends.

In the preferred embodiment of the load bed leveling module, the step 842 of accumulating is performed by transferring the plurality of bales across the load bed along a bale transferring axis disposed horizontally traverse to the bale receiving axis, at the appropriate time, to permit the accumulator to accumulate the plurality of bales in a side-by-side relationship on the load bed.

In the preferred embodiment of the load bed leveling module, the step 842 of accumulating is performed by forming at least one stack of bales, having at least two bales, along a bale stacking axis disposed vertically transverse to the bale receiving axis responsive to receiving the plurality of bales on the load bed to permit the accumulator to accumulate the at least one stack of bales on the load bed.

Hence, the general stabilization method advantageously stabilizes bales accumulated on a substantially planar load bed. The general stabilization method is particularly useful for stabilizing stacks of bales accumulated on the load bed that would otherwise have a tendency to sway, tip or shift as the accumulator travels across a bumpy or an uneven ground surface relative to the horizontal plane. However, the general stabilization method could also be used to stabilize a single layer of bales on the load bed. The general stabilization method is advantageously performed without using a bale stabilization structure permanently disposed above a bale receiving surface of the load bed, such as a fence, or a boxed in load bed to provide bale stabilization while minimizing weight, cost and storage space for the accumulator.

A. Load Bed Leveling Method And Apparatus

1. Load Bed Leveling Method

FIG. 85 illustrates a flowchart 844 describing a first particular stabilization method for performing the general stabilization method described in FIG. 84 for stabilizing bales accumulated on a load bed, by leveling the load bed along one of a longitudinal axis and a lateral axis of the load bed.

In FIG. 85, the method starts at step 848.

Next, at step 850, a first measure of levelness of the load bed is determined along a longitudinal axis, disposed substantially parallel to the bale receiving axis, relative the horizontal plane as the agricultural bale accumulator is transported across the ground surface.

Next, at step 852, a determination is made whether the first measure of levelness is desirable. If the determination at step 852 is positive, the method continues to step 854. If the determination at step 852 is negative, the method continues to step 853. In the preferred embodiment of the load bed leveling method, the step 853 includes steps 856, 858, 860 and 862.

At step 854, the leveling position, within the predetermined range of leveling positions, of the load bed is maintained along the longitudinal axis relative the horizontal plane responsive to a determination that the first measure of levelness is desirable.

At step 853, the leveling position, within the predetermined range of leveling positions, of the load bed is changed along the longitudinal axis relative the horizontal plane responsive to a determination that the first measure of levelness is undesirable.

At step 856, which is the first step in step 853, a determination is made whether the first measure of levelness has reached a maximum adjustment limit within the predetermined range of leveling positions along the longitudinal axis. If the determination at step 856 is positive, then the method returns to step 854. If the determination at step 856 is negative, then the method continues to step 857.

Returning to step 854, the leveling position, within the predetermined range of leveling positions, of the load bed is maintained along the longitudinal axis relative the horizontal plane responsive to a determination that the first measure of levelness has reached the maximum adjustment limit within the predetermined range of leveling positions along the longitudinal axis.

At step 857, the leveling position, within the predetermined range of leveling positions, of the load bed is changed along the longitudinal axis relative the horizontal plane responsive to a determination that the first measure of levelness has not reached the maximum adjustment limit within the predetermined range of leveling positions along the longitudinal axis. In the preferred embodiment of the load bed leveling method, the step 857 includes steps 858, 860 and 862.

At step 858, which is the first step in step 857, a determination is made whether the first measure of levelness indicates that a front end of the load bed or a rear end of the load bed is higher relative to the horizontal plane. If the determination at step 858 indicates that the front end of the load bed is higher, then the method continues to step 860. If the determination at step 858 indicates that the rear end of the load bed is higher, then the method continues to step 862.

At step 860, a leveling position of the load bed is changed along the longitudinal axis, within the first predetermined range of leveling positions, by lowering a front end (high) of the load bed relative to the horizontal plane and/or by raising a rear end (low) of the load bed relative to the horizontal plane. After step 860, the method continues to step 864.

At step 862, a leveling position of the load bed is changed along the lateral axis, within the first predetermined range of leveling positions, by raising a front end (low) of the load bed relative to the horizontal plane and/or by lowering a rear end (high) of the load bed relative to the horizontal plane. After step 862, the method continues to step 864.

Hence, leveling the load bed along the longitudinal axis in steps 860 and 862, compensates the load bed for an undesirable degree of levelness of the ground surface along the longitudinal axis relative to the horizontal plane.

In the preferred embodiment of the load bed leveling module, steps 860 and 862 are implemented by performing the step of pivoting the load bed about a pivot axis, disposed substantially perpendicular to the longitudinal axis and disposed substantially parallel to a lateral axis of the load bed, relative to a frame of the base module, responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane.

Preferably, the step of pivoting the load bed about the pivot axis relative to the frame further includes the step of pivoting the load bed about the pivot axis relative to the frame in one of a positive direction or a negative direction relative to the horizontal plane responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane responsive to the first measure of levelness. This is shown in FIG. 107, using the level determining device 912 and the "bent frame" configuration. This is the preferred longitudinal leveling operation.

Moreover, the step of pivoting the load bed about the pivot axis relative to the frame further includes the step of pivoting the load bed about the pivot axis between a bale receiving position and a bale discharging position relative to the frame. The load bed assumes the leveling position, within the predetermined range of leveling positions, when the load bed is in the bale receiving position to permit the load bed to receive and accumulate thereon the plurality of bales. The load bed assumes an inclined position relative to the frame when the load bed is in the bale discharging position to permit the plurality of bales to be discharged from the load bed to the ground surface under a gravitational force acting on the plurality of bales. Hence, the same mechanics and steps used for the longitudinal load bed leveling also is use for a bale discharge operation. This is the preferred longitudinal leveling operation.

Alternatively, steps 860 and 862 are implemented by performing the step of changing a frame leveling position, within a predetermined range of frame leveling positions, of a forward end portion of a frame, supporting the load bed above the ground surface, relative to a hitch on towing unit, pulling the agricultural bale accumulator in tandem behind the towing unit across the ground surface, responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane.

Continuing from one of the steps 854, 860 and 862, at step 864, a second measure of levelness of the load bed is determined along a lateral axis, disposed substantially perpendicular to the bale receiving axis, relative the horizontal plane as the agricultural bale accumulator is transported across the ground surface.

Next, at step 866 a determination is made whether the second measure of levelness is desirable. If the determination at step 866 is positive, then the method returns to step 868. If the determination at step 866 is negative, then the method continues to step 869. In the preferred embodiment of the load bed leveling method, the step 869 includes steps 870, 872, 874, 876, 878, 880, 882, 884, 886, 888, 890, 892, 894, 896 and 898.

At step 868, the leveling position, within the predetermined range of leveling positions, of the load bed is maintained along the lateral axis relative the horizontal plane responsive to a determination that the second measure of levelness is desirable.

At step 869, the leveling position, within the predetermined range of leveling positions, of the load bed is changed along the lateral axis relative the horizontal plane responsive to a determination that the second measure of levelness is undesirable.

Next, at step 870, which is the first step in step 869, a determination is made whether the second measure of levelness indicates that a right side of the load bed or a left side of the load bed is higher relative to the horizontal plane. If the determination at step 870 indicates that the right side of the load bed is higher, then the method continues to step 872. If the determination at step 870 indicates that the left side of the load bed is higher, then the method continues to step 882.

At step 872, a determination is made whether the second measure of levelness has reached a maximum adjustment limit within the predetermined range of leveling positions along the lateral axis responsive to the step 870. If the determination at step 872 is positive, then the method

continues to the step 874. If the determination at step 872 is negative, then the method continues to the step 878.

At step 874, a determination is made whether the load bed has any bale accumulating capacity remaining at a location on the load bed along the lateral axis which needs to be changed relative to the horizontal plane. In step 874, the location checked is the right (high) side of the accumulator. If the determination at step 874 is positive, then the method continues to the step 876. If the determination at step 874 is negative, then the method continues to the step 896.

At step 876, the plurality of bales are transferred along the lateral axis 202 to the right (high) side of the accumulator at the appropriate time. After step 876, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

At step 896, the leveling position, within the predetermined range of leveling positions, of the load bed is maintained along the lateral axis relative the horizontal plane.

After step 896, at step 898, the plurality of bales are transferred along the lateral axis 202 to the left (low) side of the accumulator at the appropriate time. After step 898, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

Hence, steps 872, 874, 876, 896 and 898 advantageously tries to shift the bales to the high side, if capacity is available when the leveling system has reached its maximum range. Of course, for these steps to be most effective, a transfer module capable of shifting successively received bales in the same direction across the load bed is needed. The described bale advancement module can provide such a transfer module for multiple, successive bale transfer operation. The same applies to steps 882, 884, 886, 890 and 892.

Returning to step 872, if the determination at step 872 is negative, then the method continues to the step 878.

At step 878, a leveling position of the load bed is changed along the lateral axis, within the second predetermined range of leveling positions, by lowering a right side (high) of the load bed relative to the horizontal plane and/or by raising a left side (low) of the load bed relative to the horizontal plane. After step 878, the method continues to step 880.

At step 880, the plurality of bales are transferred along the lateral axis 202 to either the right side or the left side of the accumulator, at the appropriate time. After step 880, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

Returning to step 870, if the determination at step 870 indicates that the left side of the load bed is higher, then the method continues to step 882.

At step 882, a determination is made whether the second measure of levelness has reached a maximum adjustment limit within the predetermined range of leveling positions along the lateral axis responsive to the step 870. If the determination at step 882 is positive, then the method continues to the step 888. If the determination at step 882 is negative, then the method continues to the step 884.

At step 884, a determination is made whether the load bed has any bale accumulating capacity remaining at a location on the load bed along the lateral axis which needs to be changed relative to the horizontal plane. In step 884, the location checked is the left (high) side of the accumulator. If the determination at step 884 is positive, then the method continues to the step 886. If the determination at step 884 is negative, then the method continues to the step 890.

At step 886, the plurality of bales are transferred along the lateral axis 202 to the left (high) side of the accumulator at the appropriate time. After step 886, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

At step 890, the leveling position, within the predetermined range of leveling positions, of the load bed is maintained along the lateral axis relative the horizontal plane.

After step 890, at step 892, the plurality of bales are transferred along the lateral axis 202 to the right (low) side of the accumulator at the appropriate time. After step 892, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

Returning to step 882, if the determination at step 882 is negative, then the method continues to the step 888.

At step 888, a leveling position of the load bed is changed along the lateral axis, within the second predetermined range of leveling positions, by lowering a right side (low) of the load bed relative to the horizontal plane and/or by raising a left side (high) of the load bed relative to the horizontal plane. After step 888, the method continues to step 894.

At step 894, the plurality of bales are transferred along the lateral axis 202 to either the right side or the left side of the accumulator, at the appropriate time. After step 894, the method continues to step 850 to again check the first measure of levelness of the load bed relative to the horizontal plane along the longitudinal axis.

In the preferred embodiment of the load bed leveling module, the steps 878 and 888 of changing the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane include the steps of: changing a frame leveling position, within a predetermined range of frame leveling positions, of a first side of a frame, forming a part of the base module and supporting the load bed above the ground surface, relative to a first support wheel, mechanically coupled to a first side of the frame, supporting the frame above the ground surface and permitting the agricultural bale accumulator to travel across the ground surface, responsive to the second measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane responsive to the second measure of levelness; and changing the frame leveling position, within the predetermined range of the frame leveling positions, of the second side of the frame relative to a second support wheel, mechanically coupled to a second side of the frame, supporting the frame above the ground surface and permitting the agricultural bale accumulator to travel across the ground surface, responsive to the second measure of levelness to effectuate the change of the leveling position, within the

predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane responsive to the second measure of levelness

2. Longitudinal load bed leveling Sequence

FIG. 86 illustrates, in a right side elevation view, an agricultural bale accumulator traveling over a ground surface which varies relative to a horizontal plane. A longitudinal load bed leveling module levels the load bed responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface to stabilize the bales on the load bed along the longitudinal axis. In particular, longitudinal load bed leveling module of the accumulator in FIG. 86 operates responsive to the method steps 850, 852, 853, 854, 856, 857, 858, 860 and 862.

Starting with the accumulator position at the left side of FIG. 86, a longitudinal axis of the load bed is substantially level relative to the horizontal plane because the ground surface is also level relative to the horizontal plane.

Next, as the accumulator travels in the accumulator traveling direction 221 over a longitudinally increasing grade of the ground surface, the load bed would normally remain parallel with the increasing grade of the ground surface, as shown in a dashed line. However, the longitudinal load bed leveling module determines that the first measure of levelness of the load bed along the longitudinal axis is undesirable due to the increasing grade and changes the position of the load bed by lowering the front end of the load bed and/or raising the rear end of the load bed, as shown in a solid line, to compensate for the increasing grade of the ground surface.

Next, as the accumulator travels in the accumulator traveling direction 221, the accumulator reaches a plateau having a level ground surface relative to the horizontal plane. Therefore, the longitudinal load bed leveling module determines that the first measure of levelness of the load bed along the longitudinal axis has decreased, relative to the previous longitudinally increasing grade, due to the leveling the ground surface on the plateau and changes the position of the load bed by raising the front end of the load bed and/or lowering the rear end of the load bed to compensate for the leveling grade of the ground surface.

Next, as the accumulator travels in the accumulator traveling direction 221 over a longitudinally decreasing grade of the ground surface, the load bed would normally remain parallel with the decreasing grade of the ground surface, as shown in a dashed line. However, the longitudinal load bed leveling module determines that the first measure of levelness of the load bed along the longitudinal axis is undesirable due to the longitudinally decreasing grade and changes the position of the load bed by raising the front end of the load bed and/or lowering the rear end of the load bed, as shown in a solid line, to compensate for the decreasing grade of the ground surface.

Next, as the accumulator travels in the accumulator traveling direction 221, the accumulator again reaches a level ground surface relative to the horizontal plane. Therefore, the longitudinal load bed leveling module determines that the first measure of levelness of the load bed along the longitudinal axis has increased, relative to the previous longitudinally decreasing grade, due to the leveling the ground surface and changes the position of the load bed by lowering the

front end of the load bed and/or raising the rear end of the load bed to compensate for the leveling grade of the ground surface.

3. Lateral Load Bed Leveling Sequence

FIG. 87 illustrates, in a rear side elevation view, an agricultural bale accumulator traveling over a ground surface which varies relative to a horizontal plane. A lateral load bed leveling module levels the load bed responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed along the lateral axis. In particular, lateral load bed leveling module of the accumulator in FIG. 86 operates responsive to the method steps 864, 866, 868, 869, 870, 872, 874, 876, 878, 880, 882, 884, 886, 888, 890, 892, 894, 896 and 898.

Starting with the accumulator position at the left side of FIG. 86, a lateral axis of the load bed is substantially level relative to the horizontal plane because the ground surface is also level relative to the horizontal plane.

Next, when the accumulator travels over a laterally increasing grade of the ground surface, the load bed would normally remain parallel with the increasing grade of the ground surface, as shown in a dashed line. However, the lateral load bed leveling module determines that the second measure of levelness of the load bed along the lateral axis is undesirable due to the increasing grade and changes the position of the load bed by lowering the right side of the load bed and/or raising the left side of the load bed, as shown in a solid line, to compensate for the increasing grade of the ground surface.

Next, as the accumulator reaches a plateau having a level ground surface relative to the horizontal plane. Therefore, the lateral load bed leveling module determines that the second measure of levelness of the load bed along the lateral axis has decreased, relative to the previous laterally increasing grade, due to the leveling the ground surface on the plateau and changes the position of the load bed by raising the right side of the load bed and/or lowering the left side of the load bed to compensate for the leveling grade of the ground surface.

Next, as the accumulator travels reaches a decreasing grade of the ground surface, the load bed would normally remain parallel with the laterally decreasing grade of the ground surface, as shown in a dashed line. However, the lateral load bed leveling module determines that the second measure of levelness of the load bed along the lateral axis is undesirable due to the laterally decreasing grade and changes the position of the load bed by raising the right side of the load bed and/or lowering the left side of the load bed, as shown in a solid line, to compensate for the laterally decreasing grade of the ground surface.

Next, the accumulator again reaches a level ground surface relative to the horizontal plane. Therefore, the lateral load bed leveling module determines that the second measure of levelness of the load bed along the lateral axis has increased, relative to the previous laterally decreasing grade, due to the leveling the ground surface and changes the position of the load bed by lowering the right side of the load bed and/or raising the left side of the load bed to compensate for the leveling grade of the ground surface.

4. Load Bed Leveling Apparatus

A load bed leveling module 900 includes a level determining device and a level controlling device. The level determining device determines the measure of levelness of the load bed relative to the horizontal plane as the agricultural bale accumulator is transported across the ground surface. The level controlling device changes a leveling position, within a predetermined range of leveling positions, of the load bed relative to the horizontal plane responsive to the measure of levelness to compensate for the degree of levelness of the ground surface relative to the horizontal plane thereby encouraging the plurality of bales accumulated on the load bed located at the predetermined positions to remain located at the predetermined positions as the agricultural bale accumulator is transported across the ground surface.

In the preferred embodiment of the load bed leveling module, the level controlling device positions the load bed at an intermediate leveling position between a minimum leveling position and a maximum leveling position of the predetermined range of leveling positions when the ground surface and the load bed are substantially level with the horizontal plane to permit the level controlling device to change the leveling position, within the predetermined range of leveling positions, of portions of the load bed in either a positive direction or a negative direction relative to the horizontal plane responsive to the measure of levelness.

In the preferred embodiment of the load bed leveling module, the accumulator further includes a bale transfer module adapted to transfer the plurality of bales across the load bed along a bale transferring axis disposed horizontally traverse to the bale receiving axis responsive to receiving the plurality of bales on the load bed to permit the agricultural bale accumulator to accumulate the plurality of bales in a side-by-side relationship on the load bed.

In the preferred embodiment of the load bed leveling module, the accumulator further includes a bale stacking module adapted to form at least one stack of bales, having at least two bales, along a bale stacking axis disposed vertically transverse to the bale receiving axis responsive to receiving the plurality of bales on the load bed to permit the agricultural bale accumulator to accumulate the at least one stack of bales on the load bed.

a. Lateral Load Bed Leveling Apparatus

FIGs. 88 and 89 illustrate, each in a rear side elevation view, the agricultural bale accumulator shown in FIG. 86 having a lateral load bed leveling module for leveling the load bed along the lateral axis responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed.

The level determining device 902 further includes a lateral level determining device 908 adapted to determine a second measure of levelness of the load bed along the lateral axis relative the horizontal plane 906 as the agricultural bale accumulator is transported across the ground surface. The level controlling device further includes a lateral level controlling device adapted to change the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane responsive to the second measure of levelness to compensate for the degree of levelness of the ground surface along the lateral axis relative to the horizontal plane, thereby encouraging the plurality of bales accumulated on the load bed located at

the predetermined positions to remain located at the predetermined positions as the agricultural bale accumulator is transported across the ground surface.

The lateral level controlling device is adapted to change the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative the horizontal plane when the second measure of levelness is undesirable and is adapted to not change the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative the horizontal plane when the second measure of levelness is desirable.

The lateral level controlling device further includes a first lateral level controlling device and a second lateral level controlling device. The first lateral level controlling device mechanically coupled between the first side of the frame and the first support wheel and adapted to change a frame leveling position, within a predetermined range of frame leveling positions, of the first side of the frame relative to the first support wheel responsive to the second measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane responsive to the second measure of levelness. The second lateral level controlling device mechanically coupled between the second side of the frame and the second support wheel and adapted to change the frame leveling position, within the predetermined range of the frame leveling positions, of the second side of the frame relative to the second support wheel responsive to the second measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the lateral axis relative to the horizontal plane responsive to the second measure of levelness.

Preferably, the first lateral level controlling device 910 positions the first side of the frame at a first intermediate frame leveling position between a first minimum frame leveling position and a first maximum leveling frame position of the predetermined range of frame leveling positions when the ground surface and the frame are substantially level with the horizontal plane along the lateral axis to permit the first lateral level controlling device to change the frame leveling position, within the predetermined range of frame leveling positions, the first side of the frame in either a positive direction or a negative direction relative to the horizontal plane responsive to the first measure of levelness. Preferably, the second lateral level controlling device positions the second side of the frame at a second intermediate frame leveling position between a second minimum frame leveling position and a second maximum leveling frame position of the predetermined range of frame leveling positions when the ground surface and the frame are substantially level with the horizontal plane along the lateral axis to permit the second lateral level controlling device to change the frame leveling position, within the predetermined range of frame leveling positions, the second side of the frame in either a positive direction or a negative direction relative to the horizontal plane responsive to the second measure of levelness. When operated together, the first side of the frame and the second side of the frame are substantially level with the horizontal plane along the lateral axis when the first lateral level controlling device positions the first side of the frame at the first intermediate frame leveling position and when the second lateral level controlling device

positions the second side of the frame at the second intermediate frame leveling position to permit the load bed to be substantially level with the horizontal plane along the lateral axis.

b. Longitudinal Load Bed Leveling Apparatus

FIGs. 90 and 91 illustrate, each in a right side elevation view, the agricultural bale accumulator shown in FIG. 87 having a longitudinal load bed leveling module for leveling the load bed along the longitudinal axis responsive to the first particular stabilization method described in FIG. 85 to compensate load bed for the varying ground surface thereby stabilizing the bales on the load bed.

The level determining device further includes a longitudinal level determining device 912 adapted to determine a first measure of levelness of the load bed along the longitudinal axis relative the horizontal plane as the agricultural bale accumulator is transported across the ground surface. The longitudinal level controlling device further includes a longitudinal level controlling device adapted to change the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane responsive to the first measure of levelness to compensate for the degree of levelness of the ground surface along the longitudinal axis relative to the horizontal plane, thereby encouraging the plurality of bales accumulated on the load bed located at the predetermined positions to remain located at the predetermined positions as the agricultural bale accumulator is transported across the ground surface.

The longitudinal level determining device may be implemented electrical or mechanical or electromechanical. The longitudinal level determining device is preferably mounted on the load bed parallel to the bale receiving axis.

The longitudinal level controlling device changes the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative the horizontal plane when the first measure of levelness is undesirable and does not change the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative the horizontal plane when the first measure of levelness is desirable. The change of the leveling positions may be continuous or periodic and may require a minimum predetermined amount of unlevelness before a change is made to keep the load bed from fidgeting around to provide for smoother operation.

The longitudinal level controlling device further includes a first longitudinal level controlling device mechanically coupled to a frame and the load bed and adapted to pivot the load bed about the pivot axis responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane responsive to the first measure of levelness. Preferably, the first longitudinal level compensating device is a hydraulic cylinder. Alternatively, the first longitudinal level compensating gravity may be incorporated into the gravity based discharge mechanism, described herein.

Preferably, as shown in FIG. 107, the frame has a forward end portion and a rear end portion disposed along the longitudinal axis as referenced to a forward traveling direction of the

agricultural bale accumulator. The load bed is mechanically coupled to the frame about the pivot axis at the rear end portion of the frame between a forward end portion of the load bed and a rear end portion of the load bed as referenced to the forward traveling direction of the agricultural bale accumulator. The forward end portion of the frame is disposed closer to the ground than the rear end portion of the frame as the agricultural bale accumulator is transported across the ground surface to permit the frame to be disposed at an acute angle relative to the ground surface with a closed end of the acute angle leading an open end of the acute angle as the agricultural bale accumulator is transported across the ground surface. The level controlling device positions the load bed at an intermediate leveling position between a minimum leveling position and a maximum leveling position of the predetermined range of leveling positions when the ground surface and the load bed are substantially level with the horizontal plane to permit the first longitudinal level controlling device to pivot the forward end portion of the load bed about the pivot axis in either a positive direction or a negative direction relative to the horizontal plane in correspondence with the rear end portion of the load bed being pivoted about the pivot axis in either the negative direction or the positive direction, respectively, relative to the horizontal plane, responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane responsive to the first measure of levelness. This teeter totter design advantageously increases the longitudinal leveling range eliminates any longitudinal adjustments at the hitch., as shown in FIGs. 90 and 91

Preferably the first longitudinal level controlling device is further adapted to pivot the load bed about the pivot axis between a bale receiving position and a bale discharging position relative to the frame. The load bed assumes the leveling position, within the predetermined range of leveling positions, when the load bed is in the bale receiving position to permit the load bed to receive and accumulate thereon the plurality of bales. The load bed assumes an inclined position relative to the frame when the load bed is in the bale discharging position to permit the plurality of bales to be discharged from the load bed to the ground surface under a gravitational force acting on the plurality of bales.

Alternatively, the longitudinal level controlling device further includes a second longitudinal level controlling device 914 mechanically coupled to the forward end portion of the frame and adapted to change a frame leveling position, within a predetermined range of frame leveling positions, of the forward end portion of the frame relative to the hitch responsive to the first measure of levelness to effectuate the change of the leveling position, within the predetermined range of leveling positions, of the load bed along the longitudinal axis relative to the horizontal plane responsive to the first measure of levelness.

Preferably, the second longitudinal level controlling device positions the load bed at an intermediate frame leveling position between a minimum frame leveling position and a maximum frame leveling position of the predetermined range of leveling positions when the ground surface and the load bed are substantially level with the horizontal plane to permit the second longitudinal level controlling device to change the frame leveling position, within the predetermined range of

frame leveling positions, of portions of the frame in either a positive direction or a negative direction relative to the horizontal plane responsive to the first measure of levelness.

B. Lateral Bale Stabilization Method and Apparatus

1. Lateral Bale Stabilization Method

FIG. 92 illustrates a flowchart 917 describing a second particular stabilization method for performing the general stabilization method described in FIG. 84 for stabilizing bales accumulated on a load bed, by adaptively moving the load bed extension tables between a stowed position and an unstowed position to stabilize the bales along the lateral axis of the load bed and to accumulate the bales on the load bed extension tables, respectively.

In FIG. 92, at step 916, the method starts.

At step 918, the bale accumulating capacity of the load bed is set equal to C1. The bale accumulating capacity of all of the load bed extension tables is set equal to C2. The bale accumulating capacity of the accumulator is set equal to C3 = C1 + C2.

At step 920, the load bed is pivoted to a bale receiving position, as described herein.

At step 922, the extension tables on the right side and the left side of the load bed are moved to their stowed positions, as described herein.

At step 934, the bales are received on the load bed, as described herein.

At step 926, a determination is made whether the bale received on the load bed has reached a predetermined position indicating that the bale is fully formed, as described herein. If the determination at step 926 is negative, the method returns to step 924 to continue receiving the bale. If the determination at step 926 is positive, the method continues to step 928.

At step 928, a determination is made whether the stack of bales is complete, as disclosed herein. If the determination at step 928 is negative, the method returns to step 924 to continue receiving the bale. If the determination at step 928 is positive, the method continues to step 930.

At step 930, a determination is made whether the load bed has reached its maximum bale accumulating capacity, C1. If the determination at step 930 is negative, the method continues to step 940. If the determination at step 930 is positive, the method continues to step 932.

At step 932, a determination is made whether all of the extension tables have reached their maximum bale accumulating capacity, C2. If the determination at step 932 is negative, the method continues to step 946. If the determination at step 932 is positive, the method continues to step 934.

At step 934, a determination is made whether the accumulator is ready to discharge the bales on the load bed to the ground surface. If the determination at step 934 is negative, the method returns to step 924 to continue receiving bales on the load bed. If the determination at step 934 is positive, the method continues to step 936.

At step 936, the bales are discharged from the load bed to the ground surface by pivoting the load bed to the bale discharging position. After step 936, the method continues to step 920, wherein the load bed is pivoted back to the bale receiving position. Hence, if the load bed and the load bed extension tables are filled to capacity the accumulator discharges the accumulated bales to the ground.

Returning to step 930, if the determination at step 930 is negative, the method continues to step 940.

At step 940, a determination is made whether to transfer the bales towards a right side or a left side of the load bed. If the determination at step 940 results in a decision to transfer the bales towards the right side of the load bed, the method returns to step 924. If the determination at step 940 results in a decision to transfer the bales towards the left side of the load bed, the method continues to step 944.

At step 942, the bales are transferred across the load bed (and the extension tables) towards the right side of the load bed. After step 942, the method returns to step 924 to continue receiving bales on the load bed.

At step 944, the bales are transferred across the load bed (and the extension tables) towards the left side of the load bed. After step 944, the method returns to step 924 to continue receiving bales on the load bed.

Hence, at steps 940, 942 and 944, the accumulator has remaining bale accumulating capacity on the load bed and proceeds to transfer the bales to the right and left sides of the load bed to accumulate the bales on the load bed.

Returning to step 932, if the determination at step 932 is negative, the method continues to step 946. Hence, the accumulator has determined that the load bed is filled to capacity but the load bed extension tables still have capacity remaining.

At step 946, a determination is made whether to transfer the bales towards a right side or a left side of the load bed. If the determination at step 946 results in a decision to transfer the bales towards the right side of the load bed, the method returns to step 948. If the determination at step 946 results in a decision to transfer the bales towards the left side of the load bed, the method continues to step 950.

At step 948,. an extension table on the right side of the load bed is moved to from a stowed position to an unstowed position. After step 948, the method continues to step 942, wherein the bales are transferred across the load bed (and the extension tables) towards the right side of the load bed.

At step 950, an extension table on the left side of the load bed is moved to from a stowed position to an unstowed position. After step 950, the method continues to step 944, wherein the bales are transferred across the load bed (and the extension tables) towards the left side of the load bed.

Steps 948 and 950 represent important steps in FIG. 92, because the shown how the movement of the load bed extension tables is dependent on the bale accumulating capacity of the load bed, the bale accumulating capacity and the determination of which ways to transfer the bales. These steps represent the dynamic movement of the load bed extension modules to advantageously provide for lateral bale stabilization while not significantly increasing the cost of the accumulator.

2. Lateral Bale Stabilization Sequence

FIG. 93 illustrates, in a rear side elevation view, an agricultural bale accumulator having a lateral bale stabilization module for performing a sequence of bale stabilizing and accumulating operations 952-994 responsive to the second particular stabilization method described in FIG. 92.

3. Lateral Bale Stabilization Apparatus

The lateral bale stabilization module 996 includes a first extension table, a first extension table attachment mechanism and a first extension table movement mechanism.

The first extension table is substantially planar and has a first side disposed essentially opposite to and essentially parallel to a second side of the first extension table;

The first extension table attachment mechanism is connected to the first side of the first extension table and the first side of the base module to permit the first extension table to be moveable relative to the base module between a stowed position and an unstowed position. The agricultural bale accumulator has a first bale carrying capacity when the first extension table is in the stowed position by not permitting at least one bale of the plurality of bales to be received on the first extension table. The agricultural bale accumulator has a second bale carrying capacity, greater than the first bale carrying capacity, when the first extension table is in the unstowed position by permitting at least one bale of the plurality of bales to be received on the first extension table.

The first extension table movement mechanism is connected to the first extension table and the base module and adapted to move the first extension table relative to the base module between the stowed position and the unstowed position, wherein the first extension table movement mechanism is further adapted to maintain the first extension table in the stowed position to permit physical contact between at least a portion of the first extension table and at least one bale of the plurality of bales accumulated on the load bed at a location adjacent to the first extension table to encourage the plurality of bales located at the predetermined positions on the load bed to remain located at the predetermined positions on the load bed as the agricultural bale accumulator is transported across the ground surface, and adapted to move the first extension table from the stowed position to the unstowed position responsive to the bale transfer module transferring the plurality of bales across the load bed towards the first extension table to permit the at least one bale of the plurality of bales to be transferred from the location on the load bed adjacent to the first extension table to a location on the first extension table as the agricultural bale accumulator is transported across the ground surface.

In the preferred embodiment of the lateral bale stabilization apparatus, the first extension table attachment mechanism further includes a first hinge for pivotally connecting the first side of the first extension table to the first side of the base module about a first hinge axis. The first extension table movement mechanism is adapted to cause the first extension table to pivot in an upward direction towards the base module about the first hinge axis so that the first extension table is disposed substantially perpendicular to the load bed and above a bale receiving surface of the load bed when the first extension table is in the stowed position, and is adapted to cause the first extension table to pivot in a downward direction away from the base module about the first

hinge axis so that the first extension table is disposed substantially co-planar with the load bed and adjacent to the first side of the load bed when the first extension table is in the unstowed position.

Alternatively, the first extension table attachment mechanism further includes a first sliding mechanism for slidably connecting the first side of the first extension table to the first side of the base module. The first extension table movement mechanism is adapted to cause the first extension table to retract in an inward direction towards the base module substantially parallel to the bale transfer axis so that the first extension table is disposed substantially parallel to the load bed and substantially inside a perimeter of the load bed when the first extension table is in the stowed position, and is adapted to cause the first extension table to extend in an outward direction away from the base module substantially parallel to the bale transfer axis so that the first extension table is disposed substantially co-planar with the load bed, adjacent to the first side of the load bed and substantially outside a perimeter of the load bed when the first extension table is in the unstowed position. The load bed extension module further includes a first bale stabilizing member mechanically coupled to the second side of the first extension table, wherein the first bale stabilizing member is disposed above a bale receiving surface of the first extension table to permit physical contact between the first bale stabilizing member and the at least one bale of the plurality of bales accumulated on the load bed adjacent to the first extension table when the first extension table is in the stowed position to encourage the plurality of bales located at the predetermined positions on the load bed to remain located at the predetermined positions on the load bed as the agricultural bale accumulator is transported across the ground surface and to permit physical contact between the first bale stabilizing member and the at least one bale of the plurality of bales accumulated on the bale receiving surface of the first extension table when the first extension table is in the unstowed position to encourage the plurality of bales located at the predetermined positions on the load bed and on the first extension table to remain located at the predetermined positions on the load bed and on the first extension table as the agricultural bale accumulator is transported across the ground surface.

Preferably, the lateral bale stabilization module further includes a third extension table, a third extension table attachment mechanism and a third extension table movement mechanism. The third extension table which is substantially planar, wherein the third extension table has a first side disposed essentially opposite to and essentially parallel to a second side of the third extension table. The third extension table attachment mechanism connected to the first side of the third extension table and the second side of the first extension table to permit the third extension table to be moveable relative to the base module between a stowed position and an unstowed position. The agricultural bale accumulator has one of the first and the second bale carrying capacity when the third extension table is in the stowed position by not permitting at least one of the plurality of bales to be received on the third extension table, and wherein the agricultural bale accumulator has a third bale carrying capacity, greater than one of the first and the second bale carrying capacity, when the third extension table is in the unstowed position by permitting at least one of the plurality of bales to be received on the third extension table. The third extension table movement mechanism connected to the third extension table and at least one of the first extension table and

the base module and adapted to move the third extension table relative to the base module between the stowed position and the unstowed position. The third extension table movement mechanism is further adapted to maintain the third extension table in the stowed position to permit physical contact between at least one of at least a portion of the first extension table and at least a portion of the third extension table and at least one bale of the plurality of bales accumulated at a location on one of the load bed and the first extension table adjacent to the third extension table to encourage the plurality of bales located at the predetermined positions on the load bed and on the first extension table to remain located at the predetermined positions on the load bed and on the first extension table as the agricultural bale accumulator is transported across the ground surface, and adapted to move the first extension table and the third extension table from their respective stowed positions to their respective unstowed positions responsive to the bale transfer module transferring the plurality of bales across the load bed towards the first extension table and the third extension table to permit the at least one bale of the plurality of bales to be transferred from the location on one of the load bed and the first extension table adjacent to the first extension table and the third extension table, respectively, to a location on one of the first extension table and the third extension table, respectively, as the agricultural bale accumulator is transported across the ground surface.

The first extension table attachment mechanism further comprises a first hinge for pivotally connecting the first side of the first extension table to the first side of the base module about a first hinge axis. The third extension table attachment mechanism further comprises a third hinge for pivotally connecting the first side of the third extension table to the second side of the first extension table about a third hinge axis. The first extension table movement mechanism is adapted to cause the first extension table to pivot in an upward direction towards the base module about the first hinge axis so that the first extension table is disposed substantially perpendicular to the load bed and above a bale receiving surface of the load bed when the first extension table is in the stowed position to permit physical contact between the at least a portion of the first extension table and the at least one of the plurality of bales accumulated on the load bed at the location adjacent to the first extension table to encourage the plurality of bales located at the predetermined positions on the load bed to remain located at the predetermined positions on the load bed as the agricultural bale accumulator is transported across the ground surface. The first extension table movement mechanism is adapted to cause the first extension table to pivot in a downward direction away from the base module about the first hinge axis so that the first extension table is disposed substantially co-planar with the load bed and adjacent to the first side of the load bed when the first extension table is in the unstowed position responsive to the bale transfer module transferring the plurality of bales across the load bed towards the first extension table to permit at least one bale of the plurality of bales to be transferred from the location on the load bed adjacent to the first extension table to the location on the first extension table as the agricultural bale accumulator is transported across the ground surface. The third extension table movement mechanism is adapted to cause the third extension table to pivot in an upward direction towards the base module about the third hinge axis so that the third extension table is disposed substantially perpendicular to at

least one of the load bed and the first extension table and above a bale receiving surface of at least one of the load bed and the first extension table, respectively, when the first extension table is in the stowed position to permit physical contact between the at least a portion of the third extension table and the at least one bale of the plurality of bales accumulated on one of the load bed and the first extension table, respectively, at the location adjacent to the third extension table to encourage the at least one bale of the plurality of bales located at the predetermined positions on at least one of the load bed and the first extension table, respectively, to remain located at the predetermined positions on at least one of the load bed and the first extension table, respectively, as the agricultural bale accumulator is transported across the ground surface. The third extension table movement mechanism is adapted to cause the third extension table to pivot in a downward direction away from the base module about the third hinge axis so that the third extension table is disposed substantially co-planar with the load bed and the first extension table and adjacent to the second side of the first extension table when the third extension table is in the unstowed position to permit at least one bale of the plurality of bales to be transferred from the location on the first extension table adjacent to the third extension table to the location on the third extension table as the agricultural bale accumulator is transported across the ground surface.

Preferably, the third extension table movement mechanism is a third cylinder adapted to move the third extension table relative to the base module between the stowed position and the unstowed position responsive to receiving pressurized fluid from the fluid source.

Alternatively, the third extension table movement mechanism is a counterweight movement mechanism, mechanically coupled to at least one of the base module and the first extension table, and mechanically coupled to the third extension table, and adapted to permit a weight of at least one bale of the plurality of bales disposed on at least one of the load bed and the first extension table at least one predetermined position to move the third extension table from the stowed position to the unstowed position.

a. First Lateral Bale Support Apparatus - Moveable Support Arm

FIGs. 94, 95 and 96 illustrate, each in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization module for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein the lateral bale stabilization module has a moveable support arm.

The lateral bale stabilization apparatus includes a first bale stabilizing member 998 representing the portion of the first extension table and mechanically coupled to the second side of the first extension table. The first bale stabilizing member is moveable between at least one of a stowed position, a first unstowed position, and a second unstowed position. The first bale stabilizing member is disposed substantially coplanar with the first extension table and adjacent to the second side of the first extension table when the first bale stabilizing member is in the stowed position and when the first extension table is in the stowed position. The first bale stabilizing member is disposed substantially coplanar with the first extension table and away from the second side of the first extension table when the first bale stabilizing member is in the first unstowed

position and when the first extension table is in the stowed position. The first bale stabilizing member is disposed above a bale receiving surface of the first extension table when the first bale stabilizing member is in the second unstowed position and when the first extension table is in the unstowed position to permit physical contact between at least one of the first bale stabilizing member and the first extension table and the at least one of the plurality of bales disposed on at least one of the bale receiving surface of the first extension table and the bale receiving surface of the load bed to encourage the plurality of bales located at the predetermined positions on the load bed and on the first extension table to remain located at the predetermined positions on the load bed and on the first extension table as the agricultural bale accumulator is transported across the ground surface. A hydraulic cylinder 999 moves the bale support member.

b. Second Lateral Bale Stabilization Apparatus - Decreasing Angles

FIG. 97 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization module for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein a bale receiving surface of each of a right bale accumulating portion of the load bed extension tables is disposed at progressively decreasing angles, each being somewhat less than 180°, relative to a center bale receiving portion of the load bed to progressively bias the bales accumulated thereon towards the center bale receiving portion of the load bed in proportion to an increasing distance of the accumulated bales from the center bale receiving portion of the load bed. This figure discloses: a side load bed angle 1000, a first load bed extension table angle 1002 and a third load bed extension table angle 1004.

c. Third Lateral Bale Stabilization Apparatus - Constant Angle

FIG. 98 illustrates, in a rear side elevation view, the agricultural bale accumulator shown in FIG. 93 having a lateral bale stabilization module for performing the sequence of bale stabilizing and accumulating operations shown in FIG. 93 responsive to the second particular stabilization method described in FIG. 92, wherein a bale receiving surface of each of a right bale accumulating portion of the load bed extension tables is disposed at a constant angle 1006 somewhat less than 180° relative to a center bale receiving portion of the load bed to constantly bias the bales thereon towards the center bale receiving portion of the load bed over a distance between the center bale receiving portion of the load bed and the farthest positioned load bed extension table.

5. Counterweight Mechanism - For Load Bed Extension Tables

a. General Counterweight Method

FIG. 99 illustrates a flowchart 1008 describing a general counterweight method for performing a part of the second particular stabilization method described in FIG. 92 to dynamically move a load bed extension table between a stowed position and an unstowed position responsive to a weight of a bale on the load bed adjacent to the load bed extension table.

In FIG. 99, at step 1008, the method begins.

At step 1009, a bale is accumulated on a load bed at a location on the load bed adjacent to a load bed extension table mechanically coupled to the load bed. The load bed extension table is

moveable between a stowed position and an unstowed position. The load bed extension table is permitted to stabilize the bale, located adjacent thereto, along the lateral axis of the load bed when the load bed extension table is located in its stowed position. The load bed extension table is permitted to accumulate the bale, located adjacent thereto, responsive to the bale being transferred along the lateral axis of the load bed from its location, adjacent to the load bed extension table, on the load bed onto the load bed extension table when the load bed extension table is located in its unstowed position.

At step 1010, the load bed extension table is moved from the stowed position to the unstowed position responsive to a counterweight force provided by a weight of the bale on the load bed at the location on the load bed, adjacent to the load bed extension table, and responsive to the bale being transferred from the location on the load bed to a location on the load bed extension table.

At step 1011, the method ends.

b. Particular Counterweight Method

FIG. 100 illustrates a flowchart 1010 describing a particular counterweight method for performing the general counterweight method described in FIG. 99.

In FIG. 100, at step 1012, the method starts from step 946 in FIG. 92, wherein the accumulator decides whether transfer the bales to the right side or the left side of the load bed. This particular counterweight method 1010 represents either step 948 or 950 In FIG. 92.

Next, at step 1031, a first bias force is exerted on the load bed to cause the load bed extension table to move from the unstowed position to the stowed position.

Next, at step 1041, a first latch is secured to hold the load bed extension table in the stowed position.

Next, at step 1051, a counterweight force is provided by a weight of a bale on the load bed at a location on the load bed adjacent to the load bed extension table.

Next, at step 1016, the counterweight force is applied against the first bias force to substantially reduce the effect of the first bias force.

Next, at step 1017, a second bias force is exerted on the load bed extension table to cause the load bed extension table to move from the stowed position towards the unstowed position.

Next, at step 1018, the first latch is released responsive to the bale being transferred from the location, adjacent to the load bed extension table, on to the load bed extension table to permit the second bias force to move the load bed extension table from the stowed position to the unstowed position. The precise timing between the bale transfer mechanism the load bed extension table movement may be implemented in various ways, as desired.

Next, at step 1019, a second latch is secured to hold the load bed extension table in the unstowed position.

Next, at step 1020, the method continues to step 944 or step 948 in FIG. 92.

Further, in FIG. 100, at step 1021, the method starts from step 936 in FIG. 92, wherein the bales are discharged from the load bed.

Next, at step 1022, the second latch is released responsive to the load bed pivoting from the bale discharging position to the bale receiving position after discharging the bales from the load bed to the ground surface to permit the first bias force to move the load bed extension table from the unstowed position back to the stowed position. Step 1032 informally corresponds to step 922 in FIG. 92.

Next, at step 1023, the method continues to step 924 in FIG. 92, wherein new bales are received and accumulated on the load bed.

c. Counterweight Theory Of Operation

FIGs. 101 and 102 illustrate, each in a rear side elevation view, the right side of the agricultural bale accumulator shown in FIGs. 93-98, but with only one load bed extension table, showing the theory underlying the particular and general counterweight methods described in FIGs. 99 and 100, respectively.

Generally, a counterweight of the bale is used to provide the force for how to move the load bed extension table from the stowed position to the unstowed position and the step of transferring the bale from the location on the load bed, adjacent to the load bed extension table, to the location on the load bed extension table is used to provide the timing for when to move the load bed extension table. Hence, the determinations of how and when to move the load bed extension table are the primary considerations for operation of the load bed extension table on the accumulator.

Before the load bed extension table is moved from the stowed position, the load bed extension table provides lateral stabilization for the bale. It is advantageous to leave the load bed extension table in its stowed position for as long as possible while the bales are being accumulated to maximize the time that the bales on the load bed receive lateral stabilization from the load bed extension table. Therefore, an appropriate time, for example, for when to move the load bed extension table to its unstowed position is just before the bale is going to be transferred from the location on the load bed, adjacent to the load bed extension table, to the location on the load bed extension table.

FIGs. 99 and 100 primarily illustrate the interplay of the forces among the various element shown therein to effect the counterweight apparatus. A weight of the bale located on the load bed provides a force 1020 in a negative direction along a vertical axis 203. A first bias spring produces a force 1016 is essentially a positive direction along the vertical axis 203. The load bed extension table is affected by the force of gravity on the load bed extension table itself and is represented as force 1022. A second bias spring provides a force 1018 in a negative direction along the vertical axis 203.

When a bale is not located on the load bed, adjacent to the load bed extension table, or located on the load bed extension table, the force 1016, provided by the first bias spring, is strong enough to overcome the force 1022 provided by the weight of the table alone and including any friction at the hinge 122. Therefore, the force 1016 provided by the first bias spring causes the load bed extension table to move to its stowed position, essentially perpendicular to the load bed.

When a bale is accumulated on the load bed, adjacent to the load bed extension table, the force 1020 produced by the weight of the bale on the load bed is applied against the force 1016 of the first bias spring to substantially reduce the net force 1016 applied by the first bias spring. Further, the presence of the bale on the load bed causes the second bias spring to exert a force 1018 on the load bed extension table to urge the load bed extension table towards its unstowed position.

The interplay of the four forces is shown in FIG. 102, as EQ: 1, designated by reference number 1117. On the left side of the equation 1117, the force 1022, provided by the weight of the load bed extension table, plus, the force 1018, provided by the second bias spring, if applied continuously, must be less than the force 1016 produced by the first bias spring to permit the first bias spring to overcome the weight of the load bed extension table and any force provided by the second bias spring so that the load bed extension table can move to the stowed position. On the right side of the equation 1117, the force 1020, provided by the weight of the bale, plus the force 1022, provided by the load bed extension table itself, plus the force 1018, provided by the second bias spring, must be greater than the force 1016 provided by the first bias spring to permit the weight of the table, the weight of the bale and the force of the second bias spring to overcome the first bias spring so that the load bed extension table can move to the unstowed position.

To complete a practical design, the force 1016, provided by the first bias spring and the force 1018, if any, provided by the second bias spring, are determined when the average weight of the bale and the weight of the load bed extension table, including any friction, is known. Preferably, the force 1016, provided by the first bias spring and the force 1018, if any, provided by the second bias spring are chosen so that the load bed extension table has a smooth and controlled motion when moving between its stowed and unstowed position.

The second bias spring is preferably used to kick the load bed extension table out of its stowed position, essentially perpendicular to the load bed. Hence, the force 1018 produced by the second bias spring is relatively small compared to the other three forces mentioned. Preferably, the second bias spring is engaged to apply its force 1022 only when the bale is located on the load bed, adjacent to the load bed extension table, so that the force 1016, produced by the first bias spring, does not have to work against the force 1022, produced by the second bias spring, when a bale is not located on the load bed.

Alternatively, if the second bias spring is not used an interference between the bale and the load bed extension table, during the transfer of the bale from the load bed to the load bed extension table, may be used to overcome the inertia of the load bed extension table in its stowed position to cause the load bed extension table to move to its untstowed position. However, the second bias spring is preferred to avoid the interference between the bale and the load bed extension table during the bale transfer operation.

d. Counterweight Embodiment

FIG. 103 illustrates, in a rear side elevation view, the right side of the agricultural bale accumulator shown in FIGs. 93-98, but with only one load bed extension table, having a counterweight mechanism 1014 for implementing the counterweight theory described in FIGs.

101 and 102 and for performing the particular and general counterweight methods described in FIGs. 99 and 100, respectively.

In the preferred embodiment of the counterweight embodiment, the counterweight mechanism generally includes a bale receiving plate 1028, a ratchet 1030, a gear 1032, a first bias spring 1034, a second bias spring 1036, a first latch mechanism 1024, and a second latch mechanism 1026. Also shown are the load bed 113, the load bed extension table 104, a hinge 122 connecting the load bed 113 and the load bed extension table 104 and a hinge 1038 connecting the bale receiving plate to the load bed.

The bale receiving plate 1028 provides the mechanism to capture the weight of the bale. The bale receiving plate 1028 is coupled to the load bed at a hinge 1038. The bale receiving plate 1028 may be single or multiple plates disposed on the load bed. Preferably, the bale receiving plate 1028 is a single plate having a width substantially equal to the width of the bale and having a length substantially equal to the length of the bale. With these dimensions, the force applied by the bale on the bale receiving plate 1028 will be evenly distributed along the bale receiving plate 1028. Further, a wider the bale receiving plate 1028 along the bale width requires less sliding force by the bale transfer bar 186 to push the bale on top of the bale receiving plate 1028. Other design variations of the location and construction of the bale receiving plate 1028 may be used, as desired.

The ratchet 1030 and the gear 1032 provide a counterweight transfer mechanism used to transfer the counterweight of the bale against the first bias spring. The ratchet 1030 is mechanically coupled to the bale receiving plate 1028. The gear 1032 is mechanically coupled to the first bias spring 1034. Movement of the bale receiving plate 1028 responsive to the weight of the bale disposed thereon causes the ratchet 1030 be driven in a downward direction to produce a negative force 1020 along the vertical axis, corresponding to the weight of the bale. The gear 1032 receives the negative force 1020 produced by the ratchet 1030 and is driven by the ratchet 1030 in a counterclockwise direction to generate a positive force along the vertical axis.

The first bias spring provides a passive energy storage device. The first bias spring is implemented as a torsion spring, for example, mechanically coupled to the first extension table and the base module and adapted to exert a first bias force 1016 on the extension table to permit the extension table to move from the unstowed position to the stowed position responsive to the first bias force 1016 when there are no bales disposed on the first extension table and when there are no bales disposed on the load bed at the predetermined bale receiving counterweight position. The positive force in the counterclockwise direction, provided by the gear 1032 is applied against the force 1016, produced by the first bias spring. Hence, the weight of the bale relaxes the first bias spring.

The second bias spring provides a second passive energy storage device. The second bias spring is mechanically coupled to the first extension table and the base module and exerts a second bias force on the first extension table to permit the first extension table to move from the stowed position to the unstowed position responsive to the second bias force. The second bias spring is

preferably implemented as an "L" shaped spring pin biased in an outward direction. Other various implementations may be used, as desired.

The first latch mechanism is mechanically coupled to the first extension table and the base module, at either the load bed or the frame. The first latch mechanism is holds the first extension table in the stowed position to prevent the second bias force, if applied, from moving the first extension table from the stowed position to the unstowed position while the bales are being accumulated on the load bed. The first latch mechanism releases the first extension table from the stowed position responsive to the bale transfer module transferring the bales across the load bed towards the first extension table to permit the first extension table to move from the stowed position to the unstowed position responsive to the second bias force, if applied, and to permit the bale to be transferred from the location on the load bed adjacent to the first extension table to a location on the first extension table as the accumulator is transported across the ground surface. Preferably, the first latch mechanism is released by a control arm from the push bar 186. The control arm is designed to release the first latch mechanism a few seconds before the push bar 186 begins to physically slide the bales across the load bed to permit the load bed extension table to reach its unstowed position. Various other control mechanisms, either electric or mechanical, may be used, as desired to implement the control of the first latch mechanism.

The second latch mechanism is mechanically coupled to the first extension table and the base module, at either the load bed or the frame. The second latch mechanism holds the first extension table in the unstowed position to prevent the first bias force from moving the first extension table from the unstowed position to the stowed position while the at least one of the plurality of bales is being accumulated on the load bed and on the first extension table. The second latch mechanism releases the first extension table from the unstowed position responsive to a bale discharge module discharging the plurality of bales to the ground surface to permit the first extension table to move from the unstowed position to the stowed position responsive to the first bias force. Preferably, the second latch mechanism is released when the load bed has fully returned to its bale receiving position. Note that there is no rush to move the load bed extension table back to in its stowed position, because there are not any bales located next to the load bed extension table immediately after the load bed returned to its bale receiving position. Preferably the second latch mechanism is engaged by the force of gravity on the table when the load bed is located in its bale receiving position and the load bed extension table is moved to the unstowed position. Then, movement of the load bed to the bale discharging position causes the second latch mechanism to be released when the load bed returns to the bale receiving position. Various other control mechanisms, either electric or mechanical, may be used, as desired to implement the control of the second latch mechanism.

The two latches are not required but provide for a clean, interference free design. The first latch mechanism is used to hold the load bed extension table in its stowed position even though the counter weight force has been applied against the first bias spring. Hence, when bale is ready to be transferred all that needs to be done is to release the first latch mechanism to permit the bale to be transferred onto the load bed extension table without interference from the load bed

extension table. The second latch mechanism is used to hold the load bed extension table in its unstowed position even though the counterweight force has been removed against the first bias spring during the bale discharge operation. Hence, the load bed extension table remains in its unstowed position until after the bale are discharged to prevent the load bed extension table from moving towards its stowed position while the bales are being discharged.

In summary of the counterweight embodiment, this embodiment provides for a low cost and low complexity design that still delivers automatic operation. Although, the counterweight design was described for only one load bed extension table, it should be understood that the same theory of operation and same mechanics apply to tables located on opposites sides of the load bed or multiple extension tables on one side of the load bed. In the case of multiple extension tables on one side of the load bed connected by a hinge, the counterweight becomes a bit more complicated, due to the multiple movements of the load bed extension tables, as shown in FIG. 93, but possible.

In general, the counterweight embodiment is intended to be applied to any of the load bed extension modules disclosed herein, including by example and without limitation, multiple sliding or hinged tables on one side of the load bed or on each side of the load bed, as described herein.

C. Combination Load Bed Leveling Module And Lateral Bale Stabilization Module

The load bed leveling module is advantageously combined with the lateral bale stabilization module to provide an advantageous bale stabilization module. The "bent frame" idea of FIG. 107 is used to implement the longitudinal leveling module. This embodiment, provides the flexibility of positive and negative adjustment about the pivot point and also doubles as a bale discharge module to discharge the accumulated bales to the ground. Therefore, for the longitudinal direction, this embodiment is a relatively simple and cost effective implementation. However, the lateral bale stabilization, using the lateral load bed leveling module, requires an extra mechanism to be applied between the main frame and the wheel frame which adds cost and complexity. By contrast, the lateral bale stabilization module implemented as the dynamically moving load bed extension tables is a very cost effective and relatively simple design to build. Therefore, a preferred combination is to use the longitudinal load bed leveling module as shown in FIG. 107 with the lateral bale stabilization module, as shown and described in FIGs. 92-98. This combination is not meant to be limiting, as various other combinations are possible.

X. Permissive Bale Discharge Module

FIGs. 104-111 and 74-80 illustrate a permissive bale discharge module 1052 . FIG. 104 illustrates a flowchart 1039 describing a method to be performed by one of five embodiments of an apparatus shown in FIGs. 105-111 or to be performed by the embodiment of method and apparatus shown in FIGs. 74-80.

A. Permissive Bale Discharge Method

FIG. 104 illustrates a flowchart 1039 describing a permissive bale discharge method 1039 for permitting a bale received on a bale receiving portion of a load bed 113 of an agricultural bale accumulator at a first rate of speed along a bale receiving axis 201 in a bale receiving direction to be discharged from the bale receiving portion of a load bed 113 to a ground surface 128 in a bale

discharging direction 222, essentially the same as the bale receiving direction 222, without interfering with a successively formed bale approaching the bale receiving portion of a load bed 113 during the bale discharge operation.

In FIG. 104, the method begins at step 1040.

At step 1041, a plurality of bales are successively received at an entry region 1053 on a substantially planar bale receiving portion 114 of the load bed 113 of an accumulator at a first rate of speed along the bale receiving axis 201 in a bale receiving direction 222, as described herein.

At step 1042, a determination is made whether the bale received on the load bed 113 has reached a predetermined position on the load bed 113 along the bale receiving axis 201, indicating that the bale is fully formed, as described herein. If the determination at step 1042 is negative, the method returns to step 1041 to continue receiving the bale on the load bed 113, as described herein. If the determination at step 1042 is positive, the method continues to step 1043.

At step 1043, a determination is made whether the accumulator is ready to discharge the bales from the load bed 113 to the ground surface 128, as described herein. If the determination at step 1043 is negative, the method continues to step 1046. If the determination at step 1043 is positive, the method continues to step 1044.

At step 1046, the bales are transferred across the load bed 113, as described herein, to accumulate the bale on the load bed 113. After step 1046, the method returns to step 1041 to continue receiving the bales on the load bed 113, as described herein.

At step 1044, the bales are discharged from the load bed 113 to the ground surface 128 by pivoting the load bed 113, including the bale receiving portion 114 of the load bed 113, from a bale receiving position to a bale discharging position and back to the bale receiving position in a first amount of time less than a second amount of time required for the next successive bale to be received to move through a space or gap 812, in the entry region 1053 of the load bed 113, at the first rate of speed along the bale receiving path to discharge the bales in the bale discharging direction, essentially the same as the bale receiving direction, without interfering with the next successive bale approaching the entry region 1053 of the bale receiving portion 114 of the load bed 113 during the bale discharge operation. After step 1044, the method returns to step 1041 to continue receiving the bale on the load bed 113, as described herein. Hence, the gap 812 provided in the entry region 1053 of the load bed 113 provides the load bed 113 with time to move before it can interfere with or be interfered by a successively received bale.

At step 1045 which is the first step of step 1044, a determination is made whether a next successive bale to be received on the load bed 113 will interfere with an entry region 1053 of the load bed 113 when the load bed 113 pivots from the bale receiving position towards the bale discharging position. If the determination at step 1045 is positive, the method continues to step 1047. If the determination at step 1045 is negative, the method continues to step 1048, thereby bypassing step 1047.

At step 1047, a distance, space or gap 812 along the bale receiving axis 201 is provided in the entry region 1053 of the load bed 113, without supporting the next successive bale to be received on the bale receiving portion 114 of the load bed 113, responsive to the load bed 113

pivoting from the bale receiving position towards the bale discharging position. The space may be provided dynamically, with a moveable bale support member, or statically, with no load bed 113 support in the entry region 1053 of the load bed 113.

At step 1048, the bales on the load bed 113, including the bale located on the bale receiving portion 114 of the load bed 113, are discharged to the ground surface 128 by pivoting the load bed 113 from the bale receiving position to the bale discharging position.

Hence, at steps 1045, 1047 and 1048, the gap 812 in the entry region 1053 is provided either dynamically or statically, as needed, when the load bed 113 pivots from the bale receiving position towards the bale discharging position to avoid interference with the next successive bale.

Next, at step 1049, a determination is made whether the next successive bale to be received on the load bed 113 will interfere with the entry region 1053 of the load bed 113 when the load bed 113 pivots back from the bale discharging position to the bale receiving position. If the determination at step 1049 is positive, the method continues to step 1050. If the determination at step 1049 is negative, the method continues to step 1051, thereby bypassing step 1050.

At step 1050, a distance, space or gap 812 along the bale receiving axis 201 is provided in the entry region 1053 of the load bed 113, without supporting the next successive bale to be received on the bale receiving portion 114 of the load bed 113, responsive to the load bed 113 pivoting back from the bale discharging position to the bale receiving position. The space may be provided dynamically, with a moveable bale support member, or statically, with no load bed 113 support in the entry region 1053 of the load bed 113, as is described hereinbelow.

At step 1051, the load bed 113 is pivoted back from the bale discharging position to the bale receiving position. After step 1051, the method returns to step 1041 to continue receiving the next successive bale to be received on the receiving portion of the load bed 113 along the bale receiving axis 201.

Hence, at steps 1049, 1050 and 1051, the gap 812 in the entry region 1053 is provided either dynamically or statically, as needed, when the load bed 113 pivots from the bale discharging position towards the bale receiving position to avoid interference with the next successive bale.

B. First Permissive Bale Discharge Apparatus - Load bed Notch

FIGs. 104-111 and 74-80 illustrate a permissive bale discharge module 1052 . In each of FIGs. 104-111 and 74-80 the accumulator comprises a frame 120, a load bed 113 and a bale discharge module.

The frame 120 is supported above the ground surface 128 by the wheels 108 and 110, as described herein.

The load bed 113 is substantially planar and is supported by the frame 120. The load bed 113 receives, on a bale receiving portion 114 of the load bed 113, the plurality of bales at the first rate of speed along the bale receiving axis 201 in the bale receiving direction to accumulate thereon the plurality of bales, as described hereinabove with the method in FIG. 104. The load bed 113 has an entry region 1053 designating a part of the load bed 113 where the plurality of bales are first received on the load bed 113. The load bed 113 also has a notch 1060 formed in a side of the

load bed 113, at the entry region 1053 of the load bed 113, along the bale receiving path between the bale receiving portion 114 of the load bed 113 and the entry region 1053 of the load bed 113.

The bale discharge module discharges the plurality of bales accumulated on the load bed 113 to the ground surface 128. In the preferred embodiment of the permissive bale discharge apparatus, the bale discharge module further comprises a pivot mechanism. The pivot mechanism is mechanically coupled to the frame 120 and the load bed 113 and adapted to pivot the load bed 113 between a bale receiving position and a bale discharging position. The load bed 113 is located in a horizontal position relative to the frame 120 when the load bed 113 is located in the bale receiving position. The load bed 113 is located in an inclined position relative to the frame 120 when the load bed 113 is located in the bale discharging position. The pivot mechanism pivots the load bed 113 relative to the frame 120 from the bale receiving position to the bale discharging position to discharge the plurality of bales accumulated on the load bed 113 to the ground surface 128 under a gravitational force acting on the plurality of bales.

1. Bale Support Member In The Load bed Notch

In FIGs. 105, 106, 108 and 109, the accumulator further comprises a bale support member. The bale support member is mechanically coupled to the load bed 113 at the entry region 1053 of the load bed 113 along the bale receiving path, disposed between the bale receiving portion 114 of the load bed 113 and the entry region 1053 of the load bed 113 and moveable between a bale supporting position and a bale clearing position. The bale support member is adapted to support each of the plurality of bales before they are first received at the entry region 1053 of the load bed 113 when the bale support member is located in the bale supporting position and when the load bed 113 is located in the bale receiving position. The bale support member is adapted to move to the bale clearing position when the load bed 113 pivots either to or from the bale discharging position to create a space having a predetermined distance along the bale receiving axis 201 between a next bale to be received on the load bed 113 and the entry region 1053 of the load bed 113 so that the bale support member does not interfere with the next bale of the plurality of bales to be received on the load bed 113 when the load bed 113 pivots either to or from the bale discharging position. The load bed 113 moves from the bale receiving position to the bale discharging position and back to the bale receiving position in a first amount of time less than a second amount of time required for the next bale of the plurality of bales to move through the predetermined distance at the first rate of speed along the bale receiving path.

Preferably, a bale support member movement mechanism causes the bale support member to move from the bale supporting position to the bale clearing position responsive to the load bed 113 being pivoted to the bale receiving position and causes the bale support member to move from the bale clearing position to the bale supporting position responsive to the load bed 113 being moved from the bale discharging position to the bale receiving position. The bale support member is disposed in the notch 1060, substantially coplanar with the load bed 113, when the bale support member is located in the bale supporting position. The bale support member is not disposed in the notch 1060 and is disposed beneath the bale receiving surface of the load bed 113 when the bale support member is located in the bale clearing position.

Hence, the bale support member advantageously provides a dynamic bale guide and support design while permitting the load bed 113 to pivot between the bale discharging position and the bale receiving position without interference by or with the next successive bale to be received on the load bed 113.

a. First Embodiment - Hinged Bale Support Member

FIGs. 105 and 106 illustrate, in a right side elevation view and a top side plan view, respectively an agricultural bale accumulator having a first embodiment of a permissive bale discharge module 1052 , formed by a hinged bale support member located in a load bed 113 notch 1060, operating responsive to the permissive bale discharge method 1039 described in FIG. 104.

In FIGs. 105 and 106, the bale support member movement mechanism is implemented as a hinge mechanism 1058 mechanically coupled to the load bed 113 at the entry region 1053 of the load bed 113 along the bale receiving axis 201 and having a hinge axis. The hinge mechanism 1058 mechanically couples the bale support member to the load bed 113 about the hinge axis. The bale support member pivots about the hinge axis between the bale supporting position and the bale clearing position.

Preferably, the hinge axis is disposed substantially perpendicular to the bale receiving axis 201 and substantially parallel to a lateral axis of the load bed 113 to permit the bale support member to pivot toward and away from the bales being received. This configuration provide a space in the notch 1060 along the bale receiving axis 201 of maximum length while permitting the bale support member to guide and support any bales being received, as necessary. In this preferable case, the bale support member is implemented as a substantially planar plate 1056 pivotally coupled to one side of the notch 1060 in the load bed 113. Alternatively, the hinge axis may be disposed substantially parallel to the bale receiving axis 201 and substantially parallel to a longitudinal axis of the load bed 113. In this alternate case, the bale support member may be is implemented as a substantially planar plate pivotally coupled to one side of the notch 1060 in the load bed 113 or two substantially planar plates pivotally coupled to each side of the notch 1060 in the load bed 113.

FIG. 105 also shows a distal end of the substantially planar plate 1056, opposite to the hinge mechanism 1058, slidably coupled to the main frame 120. The frame 120 has a cam 1062 provided therewith and is implemented as a curved slot, for example. The substantially planar plate 1056 has a cam follower 1064 mechanically coupled thereto and is implemented as a set of pins, for example. The cam 1062 and the cam follower 1064 advantageously permit the substantially planar plate 1056 to move between the bale supporting position and the bale clearing position responsive to the load bed 113 being moved between the bale receiving position and the bale discharging position. This relationship is reciprocal such that movement of the substantially planar plate 1056, via a hydraulic cylinder, for example, causes the load bed 113 to move, or such that movement of the load bed 113, via a hydraulic cylinder, for example, causes substantially planar plate 1056 to move. In this case, the distal end of the substantially planar plate 1056 is always connected to the frame 120. Preferably, the cam 1062 provided with the frame 120 has a curved shape to permit the distal end of the substantially planar plate 1056 to drop below any sag

in a leading end of a next successively received bale to guide the leading end up towards the top, bale receiving surface of the load bed 113 and to support the next successively received bale as it is received on the top, bale receiving surface of the load bed 113.

Alternatively, the movement of the substantially planar plate 1056 may be made dependent upon the movement of the load bed 113 by using a force transfer mechanism implemented as a spring, for example, connected from the substantially planar plate 1056 to the load bed 113 then to the frame 120. In this case, movement of the load bed 113 relative to the frame 120 to the bale discharging position applies a force to the substantially planar plate 1056 causing the substantially planar plate 1056 to move against a bias force of the spring to the bale clearing position. Likewise, movement of the load bed 113 relative to the frame 120 to the bale receiving position releases the force on the substantially planar plate 1056 causing the substantially planar plate 1056 to move with the bias force of the spring to the bale supporting position. This alternative is attractive because no hydraulic, electric or electric over hydraulic force producing devices are needed to move the substantially planar plate 1056.

Further, the substantially planar plate 1056 may also have a sloped bale receiving surface, shown in dashed lines, advantageously provided for the same bale guiding reasons as described herein below with the fourth embodiment as the sloped load bed 113.

b. Second Embodiment - Sliding Bale Support Member

FIG. 108 illustrates, in a right side elevation view, an agricultural bale accumulator having a second embodiment of a permissive bale discharge module 1052 , formed by a sliding bale support member located in a load bed 113 notch 1060, operating responsive to the permissive bale discharge method 1039 described in FIG. 104.

In FIG. 108, the bale support member movement mechanism is implemented as a slide mechanism mechanically coupled to the load bed 113 at the entry region 1053 of the load bed 113 along the bale receiving axis 201 and having a slide axis. The slide mechanism mechanically couples the bale support member to the load bed 113 about the slide axis. The bale support member slides along the slide axis between the bale supporting position and the bale clearing position.

Preferably, the slide axis is disposed substantially perpendicular to the bale receiving axis 201 and substantially parallel to a lateral axis of the load bed 113. In this preferable case, the bale support member is implemented as a substantially planar plate 1066 slidably coupled to one side of the notch 1060 in the load bed 113. Alternatively, the slide axis may be disposed substantially parallel to the bale receiving axis 201 and substantially parallel to a longitudinal axis of the load bed 113. In this alternate case, the bale support member may be is implemented as a substantially planar plate slidably coupled to one side of the notch 1060 in the load bed 113 or two substantially planar plates slidably coupled to each side of the notch 1060 in the load bed 113.

The substantially planar plate 1066 may be made to move with a bias spring in a similar manner to that described hereinabove with the first embodiment as the hinged bale support member. Further, the substantially planar plate 1066 has a sloped bale receiving surface advantageously provided for the same bale guiding reasons as described herein below with the

fourth embodiment as the sloped load bed 113. Note that the hinged bale support member is preferred over the sliding bale support member for the reason the hinged bale support member is able to dip lower than the sliding bale support member to pick up a greater amount of sag in the successively received bales. However, the sliding bale support member is advantageous over the fourth embodiment having the sloped load bed 113 with no bale support in the notch 1060, because the sliding bale support member proactively extends towards the successively received bale to pick up the sag, if any in leading end of the bale rather than waiting for the bale to reached the sloped side of the notch 1060 in the fourth embodiment.

c. Third Embodiment - Rotating Bale Support Member

FIG. 109 illustrates, in a right side elevation view, an agricultural bale accumulator having a third embodiment of a permissive bale discharge module 1052 , formed by a rotating bale support member located in a load bed 113 notch 1060, operating responsive to the permissive bale discharge method 1039 described in FIG. 104.

In FIG. 109, the bale support member movement mechanism is implemented as a rotate mechanism 1072 mechanically coupled to the load bed 113 at the entry region 1053 of the load bed 113 along the bale receiving axis 201 and having a rotate axis. The rotate mechanism 1072 mechanically couples the bale support member to the load bed 113 about the rotate axis. The bale support member rotates along the rotate axis between the bale supporting position and the bale clearing position.

Preferably, the rotate axis is disposed substantially perpendicular to the bale receiving axis 201 and substantially parallel to a lateral axis of the load bed 113. In this preferable case, the bale support member is implemented as a substantially planar plate 1068 rotatably coupled to one side of the notch 1060 in the load bed 113. The substantially planar plate 1068 has a cigar shape and is adapted to rotate 360° in either direction. A detent mechanism 1170, implemented as retractable and outwardly biased pins located on the sides of the substantially planar plate 1068 adapted to engage corresponding recesses in on the sides of the load bed 113 in the notch 1060, permits the substantially planar plate 1068 to settle into a home position, substantially parallel to and substantially coplanar with the bale receiving surface of the load bed 113, when supporting a bale being received on the load bed 113.

In operation, a bale facing end of the substantially planar plate 1068 is adapted to rotate downward if the bale facing end of the substantially planar plate 1068 contacts the next successive bale being received on the load bed 113 when the load bed 113 pivots to the bale discharging position. Hence, the substantially planar plate 1068 deflects downwardly out of the way of the bale being received. Likewise, the bale facing end of the substantially planar plate 1068 is adapted to rotate upwardly if the bale facing end of the substantially planar plate 1068 contacts the next successive bale being received on the load bed 113 when the load bed 113 pivots to the bale receiving position. Hence, the substantially planar plate 1068 deflects upwardly out of the way of the bale being received. Then, the continued receipt of the next successive bale causes the substantially planar plate 1068 to continue to rotate towards a rear side 119 of the load bed 113 until the substantially planar plate 1068 reaches its home position.

The rotating bale support member advantageously avoids interference with the next successive bale being received on the load bed 113, while providing a bale guide and a bale support, when the load bed 113 is pivoting to each of the bale receiving position and the bale discharging position. However, the rotate mechanism 1072 requires that the rotating bale support member rotate about a rotation axis about midway along the a longitudinal axis of the notch 1060 which limits the gap 812 needed to buy time for the load bed 113 discharging operation. A detailed design analysis of a desired design of an accumulator would indicate whether the benefits of this embodiment outweigh its disadvantage.

2. No Bale Support Member In The Load bed Notch

a. Fourth Embodiment - Sloped Load bed

FIGs. 110 and 111 illustrate, in a right side elevation view and a top, rear and right side perspective view, respectively, an agricultural bale accumulator having a fourth embodiment of a permissive bale discharge module 1052 , formed by a sloped load bed 113 in a load bed 113 notch 1060, operating responsive to the permissive bale discharge method described in FIG. 104.

In FIGs. 110 and 111, each of the three sides of the notch 1060 in the load bed 113 are sloped 1074 and 1076 upwards from a bottom side 111 of the load bed 113 towards a top side 109 of the load bed 113. The bale receiving surface of the load bed 113 is located on the top side 109 of the load bed 113. The sloped 1074 and 1076 may have any angle, shape or length, as desired. FIGs. 110 and 111 show the slope 1074 being about 45° relative to the bottom side 111 of the load bed 113 being substantially parallel to the top side 109 of the load bed 113. The purpose of the slope 1074, on the lateral side of the notch 1060, is to guide a forward sagging end, if any, of a successively received bale towards the top, bale receiving surface, 111 of the load bed 113. After the slope 1074, on the lateral side of the notch 1060, guides a leading end of the bale to the top, bale receiving surface, 111 of the load bed 113 and is received on the bale receiving portion 114 of the load bed 113 along the bale receiving axis 201, the slope 1074, on the lateral side of the notch 1060, no longer guides the leading end of the bale.

After the bale is fully received on the top, bale receiving surface, 111 of the load bed 113 the transfer module transfers the bale across the load bed 113. The purpose of the slope 1076, on the longitudinal sides of the notch 1060, is to guide a trailing sagging end, if any, of the last bale received on the bale receiving portion 114 of the load bed 113 to the top, bale receiving surface, 111 of the load bed 113. After the slope 1076, on the longitudinal sides of the notch 1060, guides the trailing sagging end, if any, of the last bale received on the bale receiving portion 114 of the load bed 113 to the top, bale receiving surface, 111 of the load bed 113 and the last bale receive has been transferred to a bale accumulating portion of the load bed 113, the slope 1076, on the longitudinal sides of the notch 1060, no longer guides the trailing end of the bale.

Hence, the slope 1074 and 1076 sides of the notch 1060 advantageously picks up any sag in a leading or trailing end of the last received bale to compensate for the lack of a dynamically moveable bale support member in the notch 1060, as described hereinabove. The slope 1074 and 1076 sides of the notch 1060 advantageously provides a static bale guide design which has no moving parts while permitting the load bed 113 to pivot between the bale discharging position and

the bale receiving position without interference by or with the next successive bale to be received on the load bed 113.

b. Fifth Embodiment - Pivoting Load Bed

FIG. 107 illustrates, in a right side elevation view, an agricultural bale accumulator having a fifth embodiment of a permissive bale discharge module 1052 , formed by a pivoting load bed 113 with a load bed 113 notch 1060, operating responsive to the permissive bale discharge method described in FIG. 104.

The pivoting load bed 113 with sloped sides in the notch 1060 provide the same function and benefits as described with the fourth embodiment as the sloped load bed 113 and has the additional benefit that a front side 117 of the load bed 113 can pivot downward relative to a horizontal plane to pick up a greater amount of sag in the next successively received bale. A "bent frame 120" that slopes downward relative to the horizontal place from the pivot axis towards the hitch connection to the baler advantageously permits the front side 117 of the load bed 113 to advantageously pivot downward relative to a horizontal plane.

Note that the "bent frame 120" idea is also advantageously used as a longitudinal load bed 113 leveling device to permit the load bed 113 to be leveled responsive to an indication from a level determining device 912 that the accumulator is going up a hill along an accumulator traveling path substantially parallel to the longitudinal axis of the accumulator.

Since this fifth embodiment serves multiple purposes is a first of the two co-preferred embodiments of the permissive bale discharge apparatus.

C. Second Permissive Bale Discharge Apparatus - Bale Advancement Module

FIG. 74 illustrates a flowchart describing a bale advancement method for advancing bales on a load bed 113 of an agricultural bale accumulator. FIGs. 75, 76 and 77 illustrate, each in a right side elevation view, an agricultural bale accumulator having a first embodiment of a bale advancement module performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74. FIGs. 78, 79 and 80 illustrate, each in a right side elevation view, an agricultural bale accumulator having a second embodiment of a bale advancement module performing a sequence of bale advancing operations responsive to the bale advancement method of FIG. 74.

As described with the bale advancement module hereinabove, a first bale is advanced onto the load bed 113 at a second rate of speed greater than a first rate of speed of a second bale being received on the load bed 113 to create a gap 808, in FIGs. 75, 77 and 80. The gap 808 provided by the bale advancement module is analogous to the gap 812 provided by the notch 1060, described in the first - fifth embodiments hereinabove. In both cases the gap created buys time for the accumulator to operate, such as by pivoting the load bed 113 during a bale discharge operation, before the next successive bate travels the gap 812 to reach the load bed 113. Therefore, the bale advancement module is the sixth embodiment of the permissive bale discharge apparatus to permit a bale received on the bale receiving portion 114 of the load bed 113 to be discharged from the bale receiving portion 114 of the load bed 113 to the ground.

Since this sixth embodiment also serves multiple purposes is a second of the two co-preferred embodiments of the permissive bale discharge apparatus.

In the preferred embodiment, the permissive bale discharge method is advantageously used to permit the discharge of a bale on a center, bale receiving, portion 114 of the load bed 113. However, the bale receiving portion 114 of the load bed 113 is not required to be in the center of the load bed 113, but may alternatively be located on one side of the load bed 113, for example.

Further, in each of the six embodiments, the particular dimensions of the bale support member, if appropriate, the load bed 113, the notch 1060, the frame 120, etc. and the distance of travel of the load bed 113 and the bale support member, for example, are designed to be appropriate, as desired.

XI. Selective Bale Discharge Control Module

FIGs. 112-119 illustrate a selective bale control module 1093. FIG. 112 illustrates a flowchart 1078 describing a method to be performed by an embodiment of an apparatus shown in FIGs. 113-119.

A. Selective Bale Discharge Control Method

FIG. 112 illustrates a flowchart 1078 describing a selective bale discharge method for permitting a bale receiving portion 114 of a load bed 113 of an agricultural bale accumulator 100 to discharge a bale, received along a bale receiving axis 201 in a bale receiving direction 222, from the bale receiving portion 114 of a load bed 113 to a ground surface 128 in a bale discharging direction 222, essentially the same as the bale receiving direction 222, either dependently or independently and at the same time or different times, relative to a bale accumulating portion 116 and 118 of the load bed 113 discharging accumulated bales to the ground surface 128.

At step 1079, the method starts. Next, at step 1080, a plurality of bales are received on a bale receiving portion 114 of a load bed 113 along a bale receiving axis 201. An accumulator 100 performing step 1079 is illustrated in FIGs. 113, 114, 116 and 117.

Next, at step 1081, a determination is made whether to discharge the bales from at least one of the bale receiving portion 114 of the load bed 113 and a bale accumulating portion of the load bed 113 which is located adjacent to the bale receiving portion 114 of the load bed 113. In one embodiment of the selective bale discharge control method, the determination made at step 1081 is responsive to a determination of a number and a location of the bales received and/or accumulated on the load bed 113. In another embodiment of the selective bale discharge control method, the determination made at step 1081 is responsive to a determination of a location of the accumulator 100 in a field 1135, as further described herein below. Other determinations may be made, for example and without limitation, as disclosed herein.

If the determination at step 1081 is negative, then the method continues to step 1087. If the determination at step 1081 is positive, then the method continues to step 1083.

Continuing at step 1087, a determination is made whether the last bale received has reached a predetermined position on the bale receiving portion 114 of the load bed 113 along the bale receiving axis 201, responsive to receiving the plurality of bales on the bale receiving portion 114 of the load bed 113, indicating that the last bale received is completely formed, ejected from

the bale chamber of the agricultural baler 101 and substantially received the bale receiving portion 114 of the load bed 113.

If the determination at step 1087 is negative, then method returns to step 1080 to continue receiving the bales on the bale receiving portion 114 of the load bed 113. If the determination at step 1087 is positive, then the method continues to step 1088.

Continuing at step 1088, the plurality of bales are transferred across the load bed 113 from the bale receiving portion 114 of the load bed 113 to the bale accumulating portion 116 and 118 of the load bed 113 along a bale transfer axis 202 disposed horizontally transverse to the bale receiving axis 201 responsive to bales being received on the bale receiving portion 114 of the load bed 113 to accumulate the bales on the bale accumulating portion 116 and 118 of the load bed 113. Hence, steps 1087 and 1088 describe that a bale cannot be transferred across the load bed until the bale is fully received on the bale receiving portion 114 of the load bed 113 and ejected from the baler 101.

Returning to step 1081, if the determination at step 1081 is positive, then the method continues to step 1083. At step 1083, any bales received on the bale receiving portion 114 of the load bed 113 are discharged from the bale receiving portion 114 of the load bed 113 to the ground surface 128, either dependently or independently and at the same time or different times, relative to any bales received on the bale accumulating portion 116 and 118 of the load bed 113 being discharged to the ground surface 128. After step 1083, the method returns to step 1080 to continue receiving the bales on the bale receiving portion 114 of the load bed 113. In the preferred embodiment of the selective bale discharge control method, the step 1083 further includes steps 1082, 1083, 1085, 1086, 1089, 1090, 1091 and 1092.

In the preferred embodiment of the selective bale discharge control method, the method of selectively discharging the bales accumulated on the load bed 113 from either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128, at step 1081, is performed by a step of pivoting either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 relative to a frame between a bale receiving position and a bale discharging position. Either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 is located in a horizontal position relative to the frame when either or both of bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113, respectively, is located in the bale receiving position. Either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 is located in an inclined position relative to the frame when either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113, respectively, is located in the bale discharging position. The step of pivoting causes either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to pivot relative to the frame from the bale receiving position to the bale discharging position to permit a gravitational force acting on the plurality of bales to discharge the plurality of bales accumulated

on either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128, respectively.

Returning to step 1081, if the determination at step 1081 is positive, then the method continues to step 1082 which is the first step in step 1083.

At step 1082, a determination is made whether the last bale received has reached a predetermined position on the bale receiving portion 114 of the load bed 113 along the bale receiving axis 201, responsive to receiving the plurality of bales on the bale receiving portion 114 of the load bed 113, indicating that the last bale received is completely formed, ejected from the bale chamber of the agricultural baler 101 and substantially received the bale receiving portion 114 of the load bed 113.

If the determination at step 1082 is positive, then the method continues to step 1084. If the determination at step 1082 is negative, then the method continues to step 1089.

Continuing at step 1084, a determination is made whether to discharge to the ground surface 128 any bales received on the bale receiving portion 114 of the load bed 113 and any bales accumulated on the bale accumulating portion 116 and 118 of the load bed 113 at the same time. Hence, step 1084 describes that a condition where although the accumulator 100 is ready to discharge the bales and the last received bale is fully formed and received on the bale receiving portion 114 of the load bed 113, the accumulator 100 may not decide to discharge all of the bales for one reason or another. Such a reason may be related to a location of the accumulator 100 in a field 1135, as described further hereinbelow.

If the determination at step 1084 is positive, then the method continues to step 1085. If the determination at step 1084 is negative, then the method continues to step 1089.

Continuing at step 1085, in the preferred embodiment of the selective bale discharge control method, the bale receiving portion 114 of the load bed 113 is mechanically coupled to the bale accumulating portion 116 and 118 of the load bed 113 to permit the bale receiving portion 114 of the load bed 113 to pivot between the bale receiving position and the bale discharging position with the bale accumulating portion 116 and 118 of the load bed 113 only when the bale accumulating portion 116 and 118 of the load bed 113 pivots between the bale receiving position and the bale discharging position. After step 1085, the method continues to step 1092.

Next, at step 1092, any bales received on the bale receiving portion 114 of the load bed 113 and any bales accumulated on the bale accumulating portion 116 and 118 of the load bed 113 are discharged to the ground surface 128 at the same time. An accumulator 100 performing step 1092 is illustrated in FIGs. 115 and 118. After step 1092, the method returns to step 1080 to continue receiving the bales on the bale receiving portion 114 of the load bed 113.

Returning to step 1082, if the determination at step 1082 is negative, then the method continues to step 1089. At step 1089, the bale receiving portion 114 of the load bed 113 is mechanically decoupled from the bale accumulating portion 116 and 118 of the load bed 113 to permit the bale accumulating portion 116 and 118 of the load bed 113 to pivot between the bale receiving position and the bale discharging position without the bale receiving portion 114 of the

load bed 113 when the bale accumulating portion 116 and 118 of the load bed 113 pivots between the bale receiving position and the bale discharging position.

Next, at step 1086, a determination is made whether to discharge to the ground surface 128 only the bales located on the bale receiving portion 114 of the load bed 113. If the determination at step 1086 is positive, then the method continues to step 1091. If the determination at step 1086 is negative, then the method continues to step 1090.

Continuing at step 1091, any bales received on only the bale receiving portion 114 of the load bed 113 are discharged to the ground surface 128. An accumulator 100 performing step 1091 is illustrated in FIG. 119. After step 1091, the method returns to step 1080 to continue receiving the bales on the bale receiving portion 114 of the load bed 113.

Continuing at step 1090, any bales accumulated on only the bale accumulating portion 116 and 118 of the load bed 113 are discharged to the ground surface 128. An accumulator 100 performing step 1090 is illustrated in FIGs. 114 and 117. After step 1092, the method returns to step 1080 to continue receiving the bales on the bale receiving portion 114 of the load bed 113.

In the preferred embodiment, steps 1085 and 1089 represent a dependent relationship between the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113. In this dependent relationship the bale receiving portion 114 of the load bed 113 is not permitted to discharge bales independently of the bale accumulating portion 116 and 118 of the load bed 113. While this restriction may, at first, appear limiting because it prohibits the bale receiving portion 114 of the load bed 113 from discharging the received bale without moving the bale accumulating portion 116 and 118 of the load bed 113, it should be noted that a discharge of the received bale from the bale receiving portion 114 of the load bed 113 may also be accomplished by permitting a successive bale being ejected from the baler 101 to push the last bale received off a rear side 119 of the bale receiving portion 114 of the load bed 113. Hence, this push method, effectuates a selective discharge of a bale located on the bale receiving portion 114 of the load bed 113 independently of a discharge of bales located on the bale accumulating portion 116 and 118 of the load bed 113.

In an alternative embodiment of the selective bale discharge control method, the selective bale discharge control method performs the step of pivoting by further performing a step of selectively controlling the bale accumulating portion 116 and 118 of the load bed 113 to pivot between the bale receiving position and the bale discharging position independently of the bale receiving portion 114 of the load bed 113 pivoting between the bale receiving position and the bale discharging position. In this alternative embodiment, the selective bale discharge control method selectively controls a first discharge mechanism mechanically coupled between the bale accumulating portion 116 and 118 of the load bed 113 and the frame, and selectively controlling a second discharge mechanism mechanically coupled between the bale receiving portion 114 of the load bed 113 and the frame.

B. Selective Bale Discharge Control Apparatus

FIG. 113 illustrates, in a right side elevation view, an agricultural bale accumulator 100 having a selective bale discharge module operating responsive to selective bale discharge method

described in FIG. 112, wherein the bale receiving portion 114 of the load bed 113 is located in a bale receiving position and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale accumulating position. FIG. 114 illustrates, in a right side elevation view, the agricultural bale accumulator 100 shown in FIG. 113, wherein the bale receiving portion 114 of the load bed 113 is located in the bale receiving position and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale discharging position. FIG. 115 illustrates, in a right side elevation view, the agricultural bale accumulator 100 shown in FIGs. 113 and 114, wherein each of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale discharging position. FIG. 116 illustrates, in a top side planar view, the agricultural bale accumulator 100 shown in FIGs. 113 - 115, wherein the bale receiving portion 114 of the load bed 113 is located in a bale receiving position and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale accumulating position. FIG. 117 illustrates, in a rear side elevation view, the agricultural bale accumulator 100 shown in FIGs. 113 - 115, wherein the bale receiving portion 114 of the load bed 113 is located in the bale receiving position and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale discharging position. FIG. 118 illustrates, in a rear side elevation view, the agricultural bale accumulator 100 shown in FIGs. 113 - 115, wherein each of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale discharging position. FIG. 119 illustrates, in a rear side elevation view, the agricultural bale accumulator 100 shown in FIGs. 113 - 115, wherein the bale receiving portion 114 of the load bed 113 is located in the bale discharging position and the bale accumulating portion 116 and 118 of the load bed 113 is located in a bale accumulating position. Hence, FIG. 113 corresponds to FIG. 116, FIG. 114 corresponds to FIG. 117, and FIG. 115 corresponds to FIG. 118.

In FIGs. 113-119 a selective bale discharge control apparatus selectively controls a discharge of the plurality of bales accumulated on the load bed 113 from at least one of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128.

The selective bale discharge control apparatus includes a bale position sensor 170 to determine whether the plurality of bales have reach a predetermined position on the bale receiving portion 114 of the load bed 113 along the bale receiving axis 201 responsive to receiving the plurality of bales on the bale receiving of the load bed 113 along the bale receiving axis 201. The selective bale discharge control module selectively controls the discharge of the plurality of bales accumulated on the load bed 113 from the at least one of the bale receiving portion 114 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128 responsive to the predetermined position of the bales on the bale receiving portion 114 of the load bed 113.

The selective bale discharge control apparatus includes a bale accumulating capacity sensor 172, 174 and 170 adapted to determine a number and a location of each of the bales accumulated on the load bed 113. The selective bale discharge control module selectively controls the discharge of the plurality of bales accumulated on the load bed 113 from the at least one of the bale

receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128 responsive to the number and the location of the bales accumulated on the load bed 113.

The selective bale discharge control apparatus includes a field position location module, described further hereinbelow, comprising a field position locator adapted to determine a location of the agricultural bale accumulator 100 in a field 1135. The selective bale discharge control module selectively controls the discharge of the plurality of bales accumulated on the load bed 113 from the at least one of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128 responsive to a determination of the position of the agricultural bale accumulator 100 in the field 1135.

The selective bale discharge control apparatus includes a bale discharge module adapted to discharge the plurality of bales accumulated on the load bed 113 from at least one of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 to the ground surface 128 which is preferably implemented as a pivot mechanism mechanically coupled to a frame and adapted to pivot either or both of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 between the bale receiving position and the bale discharging position, as described hereinabove. Alternatively, other types of discharge mechanism, such as a push mechanism, may be used as disclosed herein.

In the preferred embodiment of the selective bale discharge control apparatus, the bale discharge module further includes a first discharge mechanism and a second discharge mechanism. The first discharge mechanism causes the bale accumulating portion 116 and 118 of the load bed 113 to pivot between the bale receiving position and the bale discharging position. The second discharge mechanism causes the bale receiving portion 114 of the load bed 113 to pivot between the bale receiving position and the bale discharging position.

In the preferred embodiment of the selective bale discharge control apparatus, the selective bale discharge control apparatus selectively controls the second discharge mechanism and the first discharge mechanism to permit the bale receiving portion 114 of the load bed 113 to pivot between the bale receiving position and the bale discharging position only when the bale accumulating portion 116 and 118 of the load bed 113 pivots between the bale receiving position and the bale discharging position.

In the preferred embodiment of the selective bale discharge control apparatus, the second discharge mechanism is adapted to mechanically couple the bale receiving portion 114 of the load bed 113 to the bale accumulating portion 116 and 118 of the load bed 113 to permit the bale receiving portion 114 of the load bed 113 to pivot between the bale receiving position and the bale discharging position with the bale accumulating portion 116 and 118 of the load bed 113 when the first discharge mechanism pivots the bale accumulating portion 116 and 118 of the load bed 113 between the bale receiving position and the bale discharging position, and is adapted to mechanically decouple the bale receiving portion 114 of the load bed 113 from the bale accumulating portion 116 and 118 of the load bed 113 to permit the bale accumulating portion 116

and 118 of the load bed 113 to pivot between the bale receiving position and the bale discharging position without the bale receiving portion 114 of the load bed 113 when the first discharge mechanism pivots the bale accumulating portion 116 and 118 of the load bed 113 between the bale receiving position and the bale discharging position.

In the preferred embodiment of the selective bale discharge control apparatus, the second discharge mechanism is implemented as a latch mechanism 1094 adapted to mechanically couple and decouple the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113. The latch mechanism 1094 includes two pins adapted to fit into corresponding holes aligned with the pins. The pins and holes may be located on either of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113. FIG. 116, for example, shows the pins on the bale accumulating portion 116 and 118 of the load bed 113 extended into and retracting out of their corresponding holes in bale receiving portion 114 of the load bed 113. FIGs. 117 and 119, for example, show the pins on the bale accumulating portion 116 and 118 of the load bed 113 retracted out of their corresponding holes in bale receiving portion 114 of the load bed 113. FIG. 118, for example, shows the pins on the bale accumulating portion 116 and 118 of the load bed 113 extended into their corresponding holes in bale receiving portion 114 of the load bed 113. In FIGs. 116 - 119, two separate drive mechanisms, located on the bale accumulating portion 116 and 118 of the load bed 113, extends and retracts the two pins. Alternatively, only one drive mechanism, located on the bale receiving portion 114 of the load bed 113, is needed to extend and retracts the two pins when the two pins are also located on the bale receiving portion 114 of the load bed 113 and the corresponding holes are in bale accumulating portion 116 and 118 of the load bed 113.

In the preferred embodiment of the selective bale discharge control apparatus, the first discharge mechanism is a hydraulic cylinder 190 mechanically coupled between the bale accumulating portion 116 and 118 of the load bed 113 and the frame.

Hence, in the preferred embodiment of the selective bale discharge control apparatus, the hydraulic cylinder 190 produces a force to pivot the bale accumulating portion 116 and 118 of the load bed 113 between the bale receiving position and the bale discharging position and the latch mechanism 1094 operates to cause the bale receiving portion 114 of the load bed 113 to either stay in the bale receiving position or to move to the bale discharging position with the bale accumulating portion 116 and 118 of the load bed 113.

Alternatively, the selective bale discharge control apparatus selectively controls the first discharge mechanism and the second discharge mechanism to cause the bale accumulating portion 116 and 118 of the load bed 113 to pivot between the bale receiving position and the bale discharging position independently of the bale receiving portion 114 of the load bed 113 pivoting between the bale receiving position and the bale discharging position.

The independent control of the bale receiving portion 114 of the load bed 113 and the bale accumulating portion 116 and 118 of the load bed 113 is advantageous in a situation where there is a stack of bales formed on the bale receiving portion 114 of the load bed 113 and the accumulator 100, for one reason or another, as disclosed herein, decides to discharge the stack of

bales only located on the bale receiving portion 114 of the load bed 113. In this case, pivoting the bale receiving portion 114 of the load bed 113 would permit the stack of bales to be gently discharged from the ground, as disclosed herein. By contrast, permitting the next successive bale to push the stack of bales located on the bale receiving portion 114 of the load bed 113 would not be desirable because the weight of the stack of bale could be to much for the successive bale to push, thereby causing the successive bale to bind up in the baler 101. Moreover, even if the successive bale does have enough force to push the stack of bales off the rear side 119 of the load bed 113, this push method would still be undesirable because the stack of bales would most likely not retain their stacked arrangement when falling off of the bale receiving portion 114 of the load bed 113 when located in the bale receiving position, substantially horizontal with the frame 120.

In one example of the alternate embodiment of the selective bale discharge control apparatus, using hydraulic cylinder 190 to discharge the bales from the load bed 113, as described hereinabove, the first discharge mechanism further comprises a first discharge cylinder 190 mechanically coupled between the bale accumulating portion 116 and 118 of the load bed 113 and the frame, and the second discharge mechanism further comprises a second discharge cylinder mechanically coupled between the bale receiving portion 114 of the load bed 113 and the frame. A third cylinder may also be used so that one discharge cylinder is mechanically coupled to each side of the bale accumulating portion 116 and 118 of the load bed 113 to provide an even discharge force on each side of the bale accumulating portion 116 and 118 of the load bed 113.

In another example of the alternate embodiment of the selective bale discharge control apparatus, using the counterweighted load bed 113 to discharge the bales from the load bed 113, as described hereinabove, the first discharge mechanism is implemented as a first latch adapted to release the bale accumulating portion 116 and 118 of the load bed 113 from the frame when the bale accumulating portion 116 and 118 of the load bed 113 is located in the bale receiving position to permit the bale accumulating portion 116 and 118 of the load bed 113 to pivot from the bale receiving position to the bale discharging position responsive to a force of gravity exerted upon the plurality of bales accumulated on the bale accumulating portion 116 and 118 of the load bed 113 and to permit the bale accumulating portion 116 and 118 of the load bed 113 to pivot from the bale discharging position to the bale receiving position responsive to the force of gravity exerted upon the bale accumulating portion 116 and 118 of the load bed 113. Further, in this example of the alternate embodiment of the selective bale discharge control apparatus, the second discharge mechanism is implemented as a second latch adapted to release the bale receiving portion 114 of the load bed 113 from the frame when the bale receiving portion 114 of the load bed 113 is located in the bale receiving position to permit the bale receiving portion 114 of the load bed 113 to pivot from the bale receiving position to the bale discharging position responsive to a force of gravity exerted upon the plurality of bales accumulated on the bale receiving portion 114 of the load bed 113 and to permit the bale receiving portion 114 of the load bed 113 to pivot from the bale discharging position to the bale receiving position responsive to the force of gravity exerted upon the bale receiving portion 114 of the load bed 113.

Preferably, the bales are received on a center portion of the load bed 113. However, the bales may also be received along a bale receiving axis 201 which is aligned with either the right portion 116 of the load bed 113 or the left side 118 of the load bed 113. In this case, the right portion 116 of the load bed 113, for example, becomes the bale receiving portion of the load bed and the center portion 114 and the left portion 118 become the bale accumulating portion of the load bed.

XI. Bale Speed Discharge Control Module

A. Bale Speed Discharge Control Method

FIGs. 120-124 illustrate a bale speed discharge control module 1106. FIG. 120 illustrates a flowchart 1095 describing a method to be performed by an embodiment of a bale speed control discharge apparatus shown in FIGs. 121-124. FIG. 120 illustrates a flowchart 1095 describing a bale speed discharge control method for controlling a discharge speed of bales accumulated on a load bed 113 of an agricultural bale accumulator 100 as the bales are discharged from the load bed 113 to a ground surface 128 responsive to a forward traveling direction 221 of the agricultural bale accumulator 100.

In FIG. 120, at step 1096, the method starts. At step 1097, the accumulator 100 successively receives a plurality of bales on a load bed 113 of the accumulator 100. At step 1098, the accumulator 100 determines whether a received bale has reached a predetermined position on the accumulator 100 indicating that the received bale is fully formed and ejected from the baler 101, as described hereinabove. If the determination at step 1098 is negative, the method returns to step 1097 to continue receiving the bale, as described hereinabove. If the determination at step 1098 is positive, the method continues to step 1099. At step 1099, the accumulator 100 forms a stack of bales on the accumulator 100, as described hereinabove. At step 1100, the accumulator 100 determines whether the accumulator 100 is ready to discharge the stacks of bales received and accumulated on the accumulator 100 to the ground surface 128, as described herein. If the determination at step 1100 is negative, the method continues to step 1101. At step 1101, the accumulator 100 transfers the stacks of bales across the accumulator 100 to accumulate the stacks of bales on the accumulator 100, as described hereinabove. After step 1101, the accumulator 100 continues to step 1097 to receive another bale on the accumulator 100. If the determination at step 1100 is positive, the method continues to step 1102. At step 1102, the accumulator 100 determines a rate of speed that the accumulator 100 is traveling in a forward direction 221 across the ground surface 128. At step 1103, the accumulator 100 discharges the stacks of bales accumulated on the accumulator 100 from the accumulator 100 to the ground surface 128 in a rearward direction 222 essentially opposite to the forward traveling direction 221 of the accumulator 100 responsive to the rate of speed that the accumulator 100 is traveling in a forward direction 221 across the ground surface 128.

In the preferred embodiment, the determination of whether or not to discharge the stacks of bales at the step 1100, is based on one of several factors including, by example and without limitation, a bale accumulating capacity of the accumulator 100, a location of the accumulator 100 in a field

1135, and the position of a received bale on the bale receiving portion 114 of the load bed 113, as described herein.

B. Bale Speed Discharge Control Apparatus

FIG. 121 illustrates, in a top, rear and right side perspective view, an accumulator 100 having a bale speed control discharge apparatus 1108 operating responsive to the bale speed discharge control method described in FIG. 120, wherein the load bed 113 is located in a bale receiving and accumulating position. FIG. 122 illustrates, in a right side elevation view, the accumulator 100 shown in FIG. 121, wherein the load bed 113 is located in a bale receiving and accumulating position and in a bale discharging position. FIGs. 123 and 124 illustrate, each in a right side elevation view, the accumulator 100 shown in FIGs. 121 and 122, wherein the load bed 113 is located in a bale receiving and accumulating position and in a bale discharging position, respectively, and wherein the bale speed control discharge module includes an accumulator traveling speed sensing mechanism 1112, a bale engagement mechanism 1106, and a bale speed controller 1114.

In the preferred embodiment, the bale speed control discharge apparatus comprises a speed sensing mechanism 1112, a bale position sensor 170, a bale discharge controller 1114 and a bale engagement mechanism 1106. Each of the these elements of the bale speed control discharge apparatus may be implemented either electrically or mechanically, as desired.

Generally, the bale speed control discharge apparatus controls the rate of speed at which the plurality of bales accumulated on the load bed 113 are discharged from the load bed 113 to the ground surface 128 responsive to the rate of speed at which the accumulator 100 is traveling across the ground surface 128. To accomplish this, the bale engagement mechanism 1106 is positioned behind a rear side 119 of the load bed 113. In a preferred embodiment of the bale speed control discharge module, the bale engagement mechanism 1106 is located substantially coplanar with a bale accumulating surface of the load bed 113. Alternatively the bale engagement mechanism 1106 may be located on, recessed in or below the bale accumulating surface of the load bed 113 at a rearward side 119 of the load bed 113. Various types of bale engagement mechanisms provided at various locations may be implemented without departing from the spirit and the scope of the present invention.

The speed sensing mechanism 1112 determines the rate of speed at which the accumulator 100 is traveling across the ground surface 128 in a forward direction 221. The bale discharge controller 1114 controls the rate of speed at which the plurality of bales accumulated on the load bed 113 are discharged from the load bed 113 to the ground surface 128 responsive to the determined rate of speed at which the accumulator 100 is traveling across the ground surface 128. The speed sensing mechanism may be attached to the accumulator 100, to the baler 101 or the tractor. In the case of the tractor, the speed sensing mechanism is conveniently implemented as the speedometer of the tractor.

The bale position sensor translates determined location of the bales on the load bed 113 to a time when the plurality of bales accumulated on the load bed 113 first contact or are just about to contact the ground surface 128 as the plurality of bales accumulated on the load bed 113 are

discharged from the load bed 113 to the ground surface 128. The bale speed controller controls the rate of speed at which the plurality of bales, accumulated on the load bed 113, are discharged from the load bed 113 to the ground surface 128 responsive to the time when the plurality of bales accumulated on the load bed 113 first contact or are just about to contact the ground surface 128.

Generally, the bale position sensor is implemented in a similar manner to the bale positions sensors, with related adjustments, as disclosed with the bale advancement module, described hereinabove. Preferably, the bale position sensor is implemented as one or more sensing plates 170, 172, 174 located at a midsection or a forward end of the load bed 113 and having the weight of the bales disposed thereon. As bale discharge control mechanism discharges the bales towards that ground surface 128 by a predetermined distance, a trailing end of a bale, near the front side 117 of the load bed 113, moves over and past the sensing plate 170. When the sensing plate 170 pops up, upon the release of the weight of the bale, a switch, associated with the sensing plate 170, send a signal to the bale discharge controller 1114 indicating that the bale have moved the predetermined distance along the load bed 113. This predetermined distance corresponds to a time when the bales first contact or are just about to contact the ground surface 128.

The sensing plate 170 is preferably the same sensing plate used for other bale positioning functions. In this case, the signal generated by the switch is interpreted differently by the controller depending on the present mode of operation of the accumulator 100. For example, the signal provides a bale capacity indication when the load bed 113 is in the bale receiving position and provides the function for the bale position sensor 170 for the bale speed discharge control apparatus when the load bed 113 is moved from the bale receiving position towards the bale discharging position. A load bed position sensor 1107, shown in FIG. 124, provides the controller with the input signal for the controller to determine how to interpret the signal from the switch as the sensing plate 170 moves. Alternatively the sensing plate may be a separate plate dedicated to this function.

Alternatively, the bale position sensor may be implemented by the bale discharge controller 1114 receiving feedback from the bale engagement mechanism 1106. In this case the bale discharge controller 1114 tracks the number of turns, for example, that the bale engagement mechanism 1106 makes while controlling the discharge of the bales to the ground surface 128. When the number of turns equals a predetermined number of turns, the bale discharge controller 1114 knows that the bales have been discharged from the load bed 113 by a corresponding predetermined distance towards the ground surface 128.

In the preferred embodiment of the bale speed control module, the bales are first permitted to freely slide towards the bale engagement mechanism 1106 located at the rearward 119 end of the load bed 113 responsive to the load bed 113 pivoting from the bale receiving position to the bale discharging position. The bale engagement mechanism 1106 causes a leading end of the bales to stop sliding when they reach the bale engagement mechanism 1106. This operation advantageously permits the leading end of the bales to align with each other at the rearward end of the load bed 113. Then, as the load bed 113 continues to pivot towards the bale discharging position, the bale engagement mechanism 1106 engages the bales and begins to control the

discharge of the bales from the load bed 113. At this point, the bale engagement mechanism 1106 is not yet discharging the bales at the rate of speed of the accumulator's forward traveling distance. As the load bed 113 continues to pivot towards the bale discharging position and as the bale speed controller 1114 drives the bale engagement mechanism 1106 to discharge the bales from the load bed 113 at a nominal speed, the bale discharge controller 1114 is monitoring the location of the leading end of the bales, relative to the ground surface 128, via the bale position sensor 170. When the bale position sensor 170 indicates that the leading end of the bales first contact or are about to first contact the ground surface 128, the bale discharge controller 1114 increases the speed of the bale engagement mechanism 1106 to discharge the bales from a rearward side of the load bed 113 in a rearward direction 222 at substantially the same speed at which the accumulator 100 is traveling across the ground surface 128 in the forward direction 221. Alternatively, when the bale position sensor 170 indicates that the leading end of the bales first contact or are about to first contact the ground surface 128, the bale discharge controller 1114 permits the bale engagement mechanism 1106 to move freely, without control, in the rearward bale traveling direction 222 caused by the movement of the bales across the bale engagement mechanism 1106.

Note that the controlled discharge of the bales does not necessarily imply that the controlling operation is time consuming and inconvenient for an operator of the accumulator 100. On the contrary, the controlled discharge of the bales is preferably designed to happen relatively quickly, within a manner several seconds of time, to complete the entire bale speed discharge control operation. Hence, the bales are advantageously discharged to the ground surface 128 in such a manner as to maintain a neat and orderly arrangement of the accumulated bale and/or to prevent damage to the bales upon discharge while not slowing down the bale accumulation operation.

In the preferred embodiment, the bale discharge controller 1114 decreases the rate of speed at which the plurality of bales, accumulated on the load bed 113, are discharged from the load bed 113 to the ground surface 128 by applying a negative force on the plurality of bales accumulated on the load bed 113 which opposes at least a portion of the gravitational force acting on the plurality of bales accumulated on the load bed 113. Likewise, the bale discharge controller 1114 increases the rate of speed at which the plurality of bales, accumulated on the load bed 113, are discharged from the load bed 113 to the ground surface 128 by applying a positive force on the plurality of bales accumulated on the load bed 113 which aids the gravitational force acting on the plurality of bales accumulated on the load bed 113.

In the preferred embodiment, the bale engagement mechanism 1106 is implemented as a cylinder 1108 having friction providing means. The cylinder 1108 has a circumferencial surface and has an axis of rotation. The cylinder 1108 is disposed substantially coplanar with the load bed 113 and positioned at a side of the load bed 113 where the plurality of bales accumulated on the load bed 113 are to be discharged, such as ,for example, the rearward side 119 of the load bed 113. The friction providing means provides friction between the cylinder and the bales accumulated on the load bed 113 as the bales accumulated on the load bed 113 are discharged

from the load bed 113 to the ground surface 128. The bale discharge controller 1114 is coupled to the cylinder 1108 and controls a rotation of the cylinder 1108 about the axis of rotation to permit the rotation of the cylinder 1108 and the friction providing means to control the rate of speed at which the plurality of bales accumulated on the load bed 113 are discharged from the load bed 113 to the ground surface 128. Preferably, the friction providing means is provided by a plurality of spikes disposed on the circumferencial surface of the cylinder and projecting radially outward from the axis of rotation of the cylinder.

In the preferred embodiment, the speed sensing mechanism 1112 and the bale discharge controller 1114 are implemented mechanically, as shown in FIGs. 123 and 124, and generally referred to as reference number 1110. The speed sensing mechanism is implemented as a spiked ground engaging wheel 1112 and the bale discharge controller 1114 is implemented as a gear box 1114. In operation, the spiked ground engaging wheel 1112 contacts the ground surface 128 when the load bed 113 is moved to the bale discharging position relative the main frame 120. As the accumulator 100 travels in a forward direction 221 across the field 1135 with the load bed 113 in the bale discharging position, the spiked ground engaging wheel 1112 rotates in a forward rotating direction, as indicated. The gear box 1114 translates the forward rotating direction of the spiked ground engaging wheel 1112 into a reverse rotating direction to drive the bale engagement mechanism 1106, as indicated. The gear box 1114 also manages the varying speed of the bale engagement mechanism 1106 responsive to the position of the bales on the load bed 113, relative to the ground surface 128, and the inclined position of the load bed 113, relative to the frame 120, as described hereinabove.

In the preferred embodiment, the bale speed discharge control module 1106 is advantageously used in combination with the stacking module 332, as described herein to permit the stacks of bales accumulated on a single load bed 113 to be discharged from the single load bed to the ground surface 128 in such a manner that the bales remain in a neat and orderly stacked arrangement after being discharged to the ground surface 128, or to permit the bales accumulated on multiple load beds to be discharged from the multiple load beds to the ground surface 128 in such a manner so as to form stacks of bales, having a neat and orderly arrangement, on the ground surface 128. Alternatively, the bale speed discharge control module 1106 may also be advantageously used without the bale stacking module 332 when only a single layer of bales are accumulated and discharged. The bale speed discharge control module is advantageously used in the single layer of bales situation to cause a rearward end of each of the bales to align with each other prior to discharging the bales to the ground surface 128 and to discharge the bales so as not to damage the bales. In both the bale stacking situation and the single layer of bales situation, the bale speed discharge control module advantageously provides a rearward end of the discharged bales with a relatively soft landing when they are discharged to the ground surface 128.

XII. Field Location Control Module

FIGs. 125 and 126 illustrate a field location control module. FIGs. 125 and 126 illustrate flowcharts describing a method to be performed by the accumulator 100, represented in FIG. 128, when traveling across a field 1135 shown in FIG. 127.

A. General Field Location Control Method

FIG. 125 illustrates a flowchart 1115 describing a general field location control method for controlling operations, such as bale accumulation and/or bale discharge functions, of an accumulator 100 responsive to a location of the accumulator 100 in a field 1135.

At step 116, the method starts. At step 117, a location of the accumulator 100 located in a field 1135 is determined. At step 118, the accumulator 100 is operated responsive to the location of the accumulator 100 in the field 1135. The field 1135 is defined herein, for example, as a ground surface 128 of earth having crop material thereon to be harvested.

In the preferred embodiment of the field location control method, the operation of the accumulator 100 includes bale accumulation and/or bale discharge operations of the accumulator 100. In one embodiment of the field location control method, the accumulator 100 discharges the plurality of bales received and accumulated by the accumulator 100 to a ground surface 128 of the field 1135 responsive to the location of the accumulator 100 in the field 1135.

In the preferred embodiment of the field location control method, the location of the accumulator 100 in the field 1135, at step 1117, is determined by receiving a plurality of input signals transmitted by a plurality of satellites located around earth and processing the plurality of input signals to produce a location signal indicative of the location of the accumulator 100 in the field 1135. At least three signals are typically needed to produce the location signal. In the case of the accumulator's bale accumulation or bale discharging operation, the bale accumulation or discharge operation is responsive to the location signal determined by this method.

Alternatively, the location of the accumulator 100 in the field 1135, at step 1117, is determined by receiving an initialization signal indicative of a starting location 1148 of the accumulator 100 in the field 1135, receiving an input signal from a compass, determining a distance traveled by the agricultural bale accumulator in the field 1135, and processing the initialization signal, the input signal from the compass and the distance traveled by the accumulator 100 in the field 1135 to produce a location signal indicative of the location of the agricultural bale accumulator in the field 1135. In the case of the accumulator's bale accumulation or bale discharging operation, the bale accumulation or discharge operation is responsive to the location signal determined by this method.

B. Field Location Control Discharge Method

FIG. 126 illustrates a flowchart 1118 describing a particular field location control method for the general field location control method described in FIG. 125 to automatically control bale discharge functions of an accumulator 100 responsive to the location of the accumulator 100 in the field 1135. FIG. 127 illustrates, in an aerial view, a field 1135 showing a path of travel of an agricultural bale accumulator 100 across the field 1135 while performing the field location control methods described in FIGs. 126 and 127 and showing predetermined bale discharge zones 1184 in the field 1135.

In FIG. 126, the method starts at step 1119.

Next, at step 1120, a plurality of bales are received and accumulated on the accumulator 100, as described herein.

Next, at step 1121, a present number of bales received and accumulated on the accumulator 100 is determined.

Next, at step 1122, a past distance traveled by the accumulator 100 in the field 1135 is determined while the present number of bales were received and accumulated on the accumulator 100.

Next, at step 1123, an average number of bales received and accumulated on the accumulator 100 over the past distance traveled by the accumulator 100 in the field 1135 is determined responsive to the present number of bales received and accumulated on the accumulator 100, determined at step 1121, and the past distance traveled by the accumulator 100 in the field 1135, determined at step 1122. Hence, the accumulator 100 now knows about how many complete bales are being accumulated per the distance traveled by the accumulator across the field 1135.

At step 1124, a determination is made whether the present number of bales received and accumulated on the accumulator 100 is substantially equal to or less than a predetermined bale accumulating capacity of the accumulator 100. If the determination at step 1124 is positive, the method continues to step 1133. If the determination at step 1124 is negative, the method continues to step 1125. The predetermined bale accumulating capacity of the accumulator 100 may be either fixed or variable and either predetermined or dynamically determined, as described hereinabove with the bale arrangement control module 830.

Language used herein, such as, "substantially" with step 1124 incorporates a calculation that even though the accumulator 100 may not be exactly filled to its capacity, it is close enough. Close enough may mean, for example, that the accumulator 100 is over half way filled to its capacity, or it may mean that it is over ninety percent filled to its capacity. Such tolerances, are incorporated into the determination of whether the accumulator 100 has reached its maximum bale accumulating capacity. The tolerance may be incorporated by varying what the accumulator 100 is instructed as its maximum bale accumulating capacity regardless of its actual physical bale accumulating capacity available. Depending on various considerations for determining whether the accumulator 100 has reached its maximum bale accumulating capacity, the tolerances may vary during the operation of the accumulator 100. Such considerations may be the same or similar to those considerations used for the determination of the bale discharge zones 1184 described hereinbelow.

Continuing at step 1133, a determination is made whether the accumulator 100 is located in (or has recently passed through) a bale discharge zone 1184 located in the field 1135 responsive to a determination of the location of the accumulator 100 in the field 1135. If the determination at step 1133 is positive, the method continues to step 1134. If the determination at step 1133 is negative, the method continues to step 1170. Hence, the accumulator 100, having its bale accumulating capacity filled up, now needs to decide when, where and how many bales to discharge from the accumulator 100 responsive to the location of the accumulator 100 in the field 1135 relative to the bale discharge zones 1184.

The bale discharge zones 1184 may be either fixed or variable and either predetermined or dynamically determined. In the preferred embodiment of the field location control module 1115, the bale discharge zones 1184 are predetermined by an operator of the accumulator 100. In typical global positioning satellite (GPS) farming systems, an operator maps out field parameters and boundaries in advance, then downloads the electronic map of the field 1135 into a control module carried with the agricultural equipment. In the preferred embodiment of the field location control module 1115, the operator of the accumulator 100 downloads the electronic map of the desired field 1135 into a memory unit, such as that provided with the controller 1154 shown in FIG. 128, associated with the accumulator 100. The operator manually creates the bale discharge zones 1184 on the electronic map either before or after the electronic map is downloaded into the memory unit. For example, to create the bale discharge zones 1184 on the electronic map, the operator uses the user interface module 1155 by inputting a few commands to the bale discharge zones 1184 via the keypad 1156, a touchscreen display 1157, voice recognition, or the like.

Preferably, the bale discharge zones 1184 correspond to convenient locations for the discharged bales to be retrieved by a loader for loading onto a semi trailer. Other considerations for determining the bale discharge zones 1184 may include, for example and without limitation, the contour of the field 1135, the length 1140 and the width 1142 and 1144 of the field 1135, a distance 1146 between bale discharge zones 1184, a path 1137 traveled by the accumulator 100, a distance 1138 between adjacent paths traversed by the accumulator indicating a distance between windrows, for example, starting 1148 and ending 1150 locations of the accumulator 100 in the field 1135, the number of loaders available for retrieving and loading the discharged bales, the shape of the perimeter of the field 1135, the bale accumulating capacity of the accumulator 100, the pulling capacity of the tractor pulling the baler in tandem with the accumulator 100, the location of public or private access roads 1180 adjacent to the field 1135, the location of a bale storage facility 1182 located adjacent to the field 1135, to name just a few. Moreover, the bale discharge zones 1184 may have, without limitation, any number of locations in the field 1135, any size or shape 1136, discrete or continuous patterns, and be located in any location in the field 1135, for example. Preferably, the bale discharge zones 1184 are continuous, have a constant width, are located on each side of the field 1135, follow the side of the field 1135 as it broadens or narrows, are located near the public or private access road 1180 and near the bale storage facility 1182, as shown in FIG. 127, for example.

Continuing at step 1134, all of the present number of bales received and accumulated on the accumulator 100 are discharged from the accumulator 100 to the ground surface 128 in (or near) the present predetermined bale discharge zone. After step 1134, the method continues by returning to step 1120 to receive and accumulate more bales on the accumulator 100. Hence, the accumulator 100, having its bale accumulating capacity filled up and being located in a predetermined bale discharge zone, discharges all of the accumulated bales for convenient retrieval by the loader. The situation, at step 1134, represents a best case scenario of efficient farming operations which is a full accumulator 100 and all the bales being discharged in the bale discharge zone. Language used herein, such as, "in or recently passed through" with step 1133 and "in or

near" in step 1134 incorporates that calculation that even though the accumulator 100 may not be exactly in the bale discharge zone, as predetermined, it is close enough. Close enough, in FIG. 127, means that the accumulator 100 is closer to the bale discharge zone 1184 on one side of the field 1135 than the bale discharge zone 1184 on the other side of the field 1135 (i.e. less than half way to the next bale discharge zone). Such tolerances, are incorporated into the determination of the bale discharge zones 1184. Depending on the considerations mentioned herein for determining the bale discharge zones 1184, the tolerances may vary across the field 1135. Similar tolerances are also applied to step 1125.

Continuing at step 1170, some of the present number of bales received and accumulated on the accumulator 100 are discharged to the ground surface 128 prior to reaching a next predetermined bale discharge zone 1184 to be reached by the accumulator 100 as the accumulator 100 travels a remaining distance from a present location of the accumulator 100 in the field 1135 to the next predetermined bale discharge zone 1184 responsive to the location of the accumulator 100 in the field 1135 and a location of the next predetermined bale discharge zone. After step 1170, the method continues by returning to step 1120 to receive and accumulate more bales on the accumulator 100. In the preferred embodiment of the field location control module 1115, step 1170 is implemented as steps 1171, 1172 and 1173. Hence, the accumulator, having is bale accumulating capacity filled up and not be located in or near a bale discharge zone, does the next best thing which is discharging a minimum number of bales on the way to the next bale discharge zone. In this case, a loader and/ or semi trailer will still need to go into the field 1135 to retrieve the minimum number of bales discharged. However, this is better than going out to retrieve all of the bales from a full discharge of the accumulator 100, especially, when there are only a few bales and the loader can carry several bales at one time back to the semi trailer. The minimum bales are preferably discharged one at a time, but may be discharged several at a time, such as when stacks of bales are formed. The bales are preferably discharged one at a time by letting the last received bale be pushed off the accumulator 100 by the next successive bale to be received by the accumulator 100. This push operation can even be performed with the bale stacking module using one table, disclosed hereinabove, by not stacking the bales or by keeping a previously received bale in a raised or lowered position while the last received bale, coplanar with the load bed, is pushed off the load bed.

Continuing within step 1170, at step 1171, the remaining distance between the present location of the accumulator 100 in the field 1135 and the next predetermined bale discharge zone 1184 in the field 1135 to be reached by the accumulator 100 is determined responsive to the location of the accumulator 100 in the field 1135 and the location of the next predetermined bale discharge zone 1184 in the field 1135. Hence, the accumulator 100 is now calculating how much farther it must go before it can relieve its full capacity in the next bale discharge zone.

At step 1172, a future number of bales to be received and accumulated on the accumulator 100 over the remaining distance between the present location of the accumulator 100 in the field 1135 and the next predetermined bale discharge zone 1184 to be reached by the accumulator 100 is estimated responsive to the average number of bales received and accumulated on the

accumulator 100 over the past distance traveled by the accumulator 100 in the field 1135 and the remaining distance between the present location of the accumulator 100 in the field 1135 and the next predetermined bale discharge zone. Hence, the accumulator 100 is now calculating how many more bales it will probably accumulate before it can relieve its full capacity bale discharge zone.

At step 1173, the estimated future number of bales to be received and accumulated on the accumulator 100 are discharged from the load bed 113 to a ground surface 128 prior to reaching the next predetermined bale discharge zone 1184 as the accumulator 100 travels the remaining distance from the present location of the accumulator 100 in the field 1135 to the next predetermined bale discharge zone. After step 1174, the method continues by returning to step 1120 to receive and accumulate more bales on the accumulator 100. Hence, the accumulator 100 is now discharging the estimated number of bales it will probably accumulate before it can relieve its full capacity bale discharge zone. This estimation is helpful for the accumulator 100 whether to discharge the bales one at a time or in stacks, for example, to provide a convenient arrangement for the loader to pick up. A preferred arrangement of bales discharged to the ground can significantly reduce the amount of time the loader needs to retrieve the partial discharge of bales.

Returning to step 1124, if the determination at step 1124 is negative, the method continues to step 1125. At step 1125, a determination is made whether the accumulator 100 is located in (or has recently passed through) a predetermined bale discharge zone 1184 located in the field 1135 responsive to a determination of the location of the accumulator 100 in the field 1135. If the determination at step 1125 is negative, the method continues to step 1120 to receive and accumulate more bales on the accumulator 100. Hence, the accumulator 100, not having its bale accumulating capacity filled and not being located in a bale discharge zone, continues on to receive and accumulate bales.

If the determination at step 1125 is positive, the method continues to step 1126. At step 1126, a determination is made whether the accumulator 100 should discharge the present bales accumulated on the accumulator 100 in the present predetermined bale discharge zone 1184 as opposed to continuing to accumulate future bales for discharge at the next predetermined bale discharge zone. In the preferred embodiment of the field location control module 1115, step 1126 is implemented as steps 1127, 1128, 1129 and 1131. Hence, the accumulator 100, not having its bale accumulating capacity filled but now being located in a bale discharge zone, now needs to decide whether to discharge the bales that it has in the present bale discharge zone 1184 or whether it can make it to the next bale discharge zone 1184 before maximizing its bale accumulating capacity. The accumulator 100 is trying to avoid a situation where unsuspectingly passes up an opportunity to discharge the bales it has in a dump zone only to find itself filled to capacity far from the next bale discharge zone.

If the determination at step 1126 is positive, the method continues to step 1132. At step 1132, the present bales accumulated on the accumulator 100 are discharged in the present predetermined bale discharge zone 1184 from the accumulator 100 to the ground surface 128 and the method continues to step 1120 to receive and accumulate more bales on the accumulator 100.

If the determination at step 1126 is negative, the method continues to step 1120 to receive and accumulate more bales on the accumulator 100, without discharging any bales.

Returning to step 1125, if the determination at step 1125 is positive, the method continues to step 1127 described first in step 1126.

At step 1127, the present number of bales received and accumulated on the accumulator 100 are subtracted from the predetermined bale accumulating capacity of the accumulator 100 to determine the remaining number of bales that the accumulator 100 can receive and accumulate before the predetermined bale accumulating capacity of the accumulator 100 reaches its maximum limit. Hence, the accumulator 100 has determined the number of open spaces available for new bales to be received.

At step 1128, a remaining distance between a present location of the accumulator 100 in the field 1135 and the next predetermined bale discharge zone 1184 to be reached by the accumulator 100 is determined. Hence, the accumulator 100 has determined how much farther it has to travel with only the determined number of open spaces available.

At step 1129, the average number of bales received and accumulated on the accumulator 100 over the past distance traveled by the accumulator 100 in the field 1135 is multiplied by the remaining distance between a present location of the accumulator 100 in the field 1135 and the next predetermined bale discharge zone 1184 to be reached by the accumulator 100 to determine the future number of bales that the accumulator 100 can receive and accumulate before the accumulator 100 reaches the next predetermined bale discharge zone. Hence, the accumulator 100 uses its past calculated data to estimate how many more bales the accumulator 100 can expect to receive before reaching the next bale discharge zone.

At step 1131, a determination is made whether a future number of bales that the accumulator 100 can receive and accumulate before the accumulator 100 reaches the next predetermined bale discharge zone 1184 is greater than a remaining number of bales that the accumulator 100 can receive and accumulate before reaching the predetermined bale accumulating capacity of the accumulator 100. Hence, the accumulator 100 compare its determined number of open spaces available for additional bales to be received to its estimate of how many more bales the accumulator 100 can expect to receive before reaching the next bale discharge zone 1184 to determine if it has enough bale accumulating capacity available to accumulate the estimated number of bales it expects to receive.

If the determination at step 1131 is positive, the method continues to step 1132. At step 1132, the present bales accumulated on the accumulator 100 are discharged in the present predetermined bale discharge zone 1184 from the accumulator 100 to the ground surface 128. Hence, the accumulator 100 decides that it does not have enough capacity to accumulate the estimated number of bale to be received before reaching the next dump zone and that it is better to discharge the partially filled accumulator 100 in the present bale discharge zone.

If the determination at step 1131 is negative, the method continues to step 1120 to receive and accumulate more bales on the accumulator 100. Hence, the accumulator decides that it does have enough capacity to accumulate the estimated number of bale to be received before reaching

the next dump zone and that it is better to continue to accumulate more bales to discharge a larger number of bales at the next bale discharge zone.

The flowcharts 1115 and 1118 are provided by example only and are not meant to be limiting. Various modifications to the flowcharts can be made within the scope of the present invention. For example, a manual override to provide instant discharge can also be provided. Further, all of the steps to not need to be implemented to provide for simpler operation.

The field location control method, as described in FIG. 1118, advantageously decides when and where to discharge the accumulated bales so that the operator does not have to decide. Therefore, the field location control method greatly reduces a burden on the operator to continuously monitor the accumulation operation relative to a location of the accumulator 100 in the field 1135, as well as other considerations mentioned herein above, in order to manually discharge the bales at the desired locations. Alternatively, on the other end of the spectrum when the bales are automatically discharged only when the accumulator 100 is filled, the field location control method provides intelligent discharge of the bales to avoid the discharge of the bales at inappropriate locations in the field 1135.

The description of the field location control module provides an excellent example of an environment in which the accumulator 100 can utilize the various modules disclosed herein. For example, the accumulator 100 advantageously uses the load bed extension module 120 and the bale stacking module 332 to increase its bale accumulating capacity in order to have greater flexibility of how to accumulate as well as how and when to discharge the bales relative to the bale discharge zones 1184 in the field 1135, as used in step 1124 of FIG. 126, for example. The bale arrangement control module 830 advantageously permits various dynamic bale arrangement responsive to various input conditions, including the location of the accumulator 100 in the field 1135, as used in step 1120 of FIG. 126, for example. The bale advancement module 798 advantageously advances fully formed bales onto the accumulator 100 ahead of a next successive bale to be received to permit the accumulator 100 to have enough time to handle the received bale, such as to form the stacks of bales, without interfering with or without interference from the next successive bale, as used in step 1120, for example. The bale stabilization module 899, advantageously automatically stabilizes the dynamic arrangement of bales responsive to the location of the accumulator 100 in the field 1135, for example, and as used in step 1120 of FIG. 126, for example. The permissive bale discharge module 1052 advantageously permits the bale on the bale receiving portion of the load bed to be discharged, when desired, to free up additional bale accumulation capacity on the accumulator 100 when the bales are discharged from the accumulator 100, as used in steps 1173, 1134 and 1132 of FIG. 126, for example. The selective bale discharge control module 1093 advantageously permits the bales on at least one of the bale receiving portion of the load bed and the bale accumulating portion of the load bed to be discharged, as used in steps 1173, 1134 and 1132 of FIG. 126, for example. The bale speed discharge control module 1106 advantageously controls the discharge of the bales, accumulated on the load bed, to the ground surface 128 responsive to the forward traveling speed of the accumulator 100, as used in steps 1173, 1134 and 1132 of FIG. 126, for example. And, of

course, the field location control module 1115 utilizes, a GPS received signal, for example, to optimize the bale accumulating and bale discharging operations of the accumulator 100 having one or more of these modules and other modules, such as the bale transfer module 186, the bale discharge module 190, the base module 112, the baler interface module 1163, the tractor interface module 1164, the real time clock module 1165 and the user interface module 1115.

C. Field Location Control Apparatus

The field position location control apparatus comprises a field position locator and a controller 1154. The field position locator generates a location signal indicative of a location of the accumulator 100 in a field 1135. The controller 1154 controls an operation of the accumulator 100 responsive to receiving determined the location signal.

The field position locator is preferably implemented as a Global Positioning Satellite (GPS) receiver. The GPS receiver may be mounted on the accumulator 100, on the baler or on the tractor. Since manufacturers are already providing GPS receivers on tractors and balers and due to the present day cost of the GPS receivers, the GPS receiver of the field location control apparatus is preferably the same GPS receiver as that GPS receiver used on either the baler or the tractor. In this case, the location signal produced by the GPS receiver is sent to the controller 1154 on the baler, on the tractor, or on the accumulator 100 to generate control signals, as disclosed herein, for the accumulator 100. When the GPS receiver is located on the baler or the tractor, the location signal or the control signals from the controller 1154 are sent to the accumulator 100 via the baler interface module 1163 and the tractor interface module 1164, respectively. The controller 1154 is implemented as described in FIG. 128.

Alternatively, the field position locator is a compass and used as, as described with the field location control method, hereinabove. The location signal produced the by the method using the compass is used in the same manner as the location signal produced by the GPS receiver. The method using the compass is advantageous over the GPS receiver because the compass is less expensive. However, the method using the compass has the disadvantage that it is dependent on the starting point in the field 1135. Whereas, the GPS receiver provides a location signal indicative of a definite location of the receiver regardless of the starting point. Further, advances in technology is rapidly causing the cost of GPS receiver to decrease.

Operations controlled by the accumulator 100 responsive to the position of the accumulator 100 in a field 1135 include, for example and without limitation, operations of: the load bed extension module 120, the bale stacking module 332, the bale arrangement control module 830, the bale advancement module 798, the bale stabilization module 899, the permissive bale discharge module 1052, the selective bale discharge control module 1093, the bale speed discharge control module 1106, the bale transfer module 186, the bale discharge module 190, the base module 112, the baler interface module 1163, the tractor interface module 1164, the real time clock module 1165, and the user interface module 1115.

XIII. Agricultural Bale Accumulator Block Diagram

FIG. 128 illustrates a block diagram 1152, representing the accumulator 100 and method therefor shown in FIGs. 1-127 and 129-132,. The block diagram 1152 generally includes a

controller having a memory unit, the load bed extension module 102, the bale stacking module 332, the bale arrangement control module 830, the bale stabilization module 899, the permissive bale discharge module 1052, the selective bale discharge control module 1093, the bale speed discharge control module 1106, the bale advancement module 798, the field locator module 1115, the bale discharge module 190, the bale transfer module 186, the base module 112, a baler interface module 1163, a tractor interface module 1164, a real time clock module 1165 and a user interface module 1155. The user interface module 1155 further includes a keypad 1156, a display 1157, a compact disk or floppy disk drive 1158, visual indicators 1159, audible indicators 1160, a computer interface 1161, and an internet or an intranet interface 1162.

Each of the load bed extension module 102, the bale stacking module 332, the bale arrangement control module 830, the bale stabilization module 899, the permissive bale discharge module 1052, the selective bale discharge control module 1093, the bale speed discharge control module 106, the bale advancement module 798, the field locator module 1115, the bale discharge module 190, the bale transfer module 186, and the base module 112 are implemented as disclosed herein and each have sensors associated therewith. The sensors provide the controller 1154 with information related to locations of bales on the accumulator, locations of moveable apparatus and mechanisms associated with the accumulator, characteristics of the bales, such as length, width, height, weight, type, moisture content, etc., locations of the accumulator in the field. The sensors provide the controller 1154 with information about what is going on with the accumulator 100 so that the controller can cause the accumulator to operate appropriately. Some of the sensors inform the controller 1154 that an action needs to be or can be taken. Other sensors provide positive feedback to the controller 1154 that an action initiated by the controller has been completed.

The controller 1154 may be implemented electrically, mechanically or a combination of the two, since some modules may be implemented more conveniently, less expensively or more simply with a particular implementation. Further, the controller 1154, implemented as an electrical embodiment, may reside on the accumulator 100, on a baler 101 or on a tractor, or partially on any of the three units. In the case of the controller 1154 being located remotely on the baler 101 or on the tractor, the accumulator would have an electrical interface, connected to the various sensors and control mechanisms, adapted for connection to the remotely located controller, via the baler interface module 1163 or the tractor interface module 1164. Whether the controller 1154 is located locally on the accumulator 100 or remotely on the baler 101 or tractor depends on whether the units are sold together or separately, sold by the same manufacturer, etc.

The memory unit in the controller 1154, implemented electrically, stores all of the methods disclosed as flowcharts herein to control the accumulator 100 as disclosed herein.

The real time clock module 1165 provide a real time clock signal for the controller 1154 for use with the modules as described herein. Generally, the real time clock signal is used by the controller 1165 to control the timing of the various apparatus and mechanism of the modules.

The user interface module 1155 is preferably located in a tractor cab for use by an operator of the accumulator being towed behind the tractor and baler 101. Preferably, the user interface

module 1155 is integrated with other user interfaces that the operator has to operate and monitor the tractor and the baler 101.

The keypad 1156 permits a person to enter data into the controller 1154 related to the operation of the accumulator 100 as disclosed herein. Such data inputs may include, for example and without limitation: a particular combination of modules installed on the accumulator 100, the desired position of the load bed extension tables of the load bed extension module 102, the desired bale arrangement of the bale arrangement control module 830, the range of leveling positions or the lateral bale stabilization operation of the bale stabilization module 899, a desired control of the selective bale discharge module 1093, an adjustment of bale speed upon discharge of the bale speed discharge control module 1106, the adjustment of the first predetermined position or the second predetermined positions, or the speed of bale advancement of the bale advancement module 798, and the desired bale discharge zones of the field location control module 1115.

The display 1157 permits a person to receive data produced by the controller 1154 related to the operation of the accumulator 100 as disclosed herein. Such provided data may include, for example and without limitation: a particular combination of modules installed on the accumulator 100, a graphic or numeric depiction of a position of the load bed extension tables of the load bed extension module 102, a graphic or numeric depiction of the bale arrangement of the bale arrangement control module 830, a graphic or numeric depiction of leveling positions or the lateral bale stabilization operation of the bale stabilization module 899, a graphic or numeric depiction of the control of the selective bale discharge module 1093, a graphic or numeric depiction of the speed at which the bales are discharged of discharge of the bale speed discharge control module 1106, a graphic or numeric depiction of the adjustment of the first predetermined position or the second predetermined positions, or the speed of bale advancement of the bale advancement module 798, and a graphic or numeric depiction of the desired bale discharge zones and the bale being discharged therein of the field location control module 1115. Such graphic depiction's may be similar to any of the various figures disclosed herein which illustrate, by example and without limitation, the operation of the accumulator 100, the locations of the bales, sequence of bale handling operations, location of the accumulator 100 in the field, etc.

The compact disk or floppy disk drive 1158 permits a person to manually transfer data between the controller 1154 and a remote controller located, for example, in a personal computer.

The visual indicators 1159, implemented as lights, and the audible indicators 1160, implemented as a speaker or a horn, provides a person with visual and audible sensory alerts, alarms, indications, prompts, messages, etc., while operating the accumulator 100.

The computer interface 1161, implemented as a direct line connection or a radio frequency connection, permits a transfer data between the controller 1154 and a remote site such as a remote controller located, for example, in a personal computer. The transfer may be initiated manually or may be automatic. In the preferred embodiment, the computer interface 1161 is the radio frequency connection and is implemented with a radio communication device and a radio frequency modem. The radio communication device is a cellular telephone, for example, compatible with the modem. The radio frequency connection is a powerful interface because it

permits information related to the operation of the accumulator 100, the baler 101, the tractor, or any other type of agricultural equipment to transmit to a remote site and receive from remote site real time data related to the operation of the agricultural equipment. Such data may be transferred to a person's remote personal computer, for example, for real time input and analyzing. Such data may include, for example and without limitation, equipment status, maintenance and operation, field preparation, crop planting, crop maintenance and crop harvesting information. In particular, information related to the accumulator 100 includes, for example and without limitation, bale yield, characteristics of the bales, such as length, width, height, weight, type, moisture content, etc., and locations of the accumulator and distance traveled by the accumulator in the field. The radio frequency connection is also be used for emergency or maintenance purposes to alert a person or a computer at a remote site that the operator of the agricultural equipment or the agricultural equipment itself needs assistance. The data received via the radio frequency connection is sent by a person or remote computer that is analyzing the real time operation of the agricultural equipment and is providing feedback to the agricultural equipment for appropriate corrections, if needed, either manually by the operator of the agricultural equipment or automatically by the agricultural equipment itself.

The internet or the intranet interface 1162 permits an operator of agricultural equipment, such as the accumulator 100, the baler 101 or the tractor, for example, to have access to an intranet or the internet. The internet or the intranet interface 1162, is implemented with the radio frequency connection, as described hereinabove and appropriate browsing software to access the internet or the intranet. Recently, the internet has quickly gained acceptance as a device for searching and retrieving information. Further, the internet is rapidly expanding into a multitude of applications including, for example and without limitation, electronic commerce, multimedia, voice communications, to name a few. The agricultural equipment uses, either manually by the operator of the agricultural equipment or automatically by the agricultural equipment itself, the internet interface to transmit data to a remote internet site or receive data from the remote internet site. Such data includes, for example and without limitation, any of the information disclosed herein.

XIV. Bale Accumulator Having A Combination Of Modules

FIGs. 129-132 illustrate the accumulator 100 including an embodiment of each of the abovementioned modules. FIG. 129 illustrates, in a rear side elevation view, an agricultural bale accumulator having a preferred combination of each of the modules disclosed herein. FIG. 130 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIG. 129, wherein a load bed of the agricultural bale accumulator is located in a bale receiving and accumulating position relative to a main frame. FIG. 131 illustrates, in a top side plan view, the agricultural bale accumulator shown in FIGs. 129 and 130. FIG. 132 illustrates, in a right side elevation view, the agricultural bale accumulator shown in FIGs. 129 - 131, wherein the load bed is located in a bale discharging position relative to the main frame to permit bales accumulated on the load bed to be discharged to a ground surface.

It should be evident from the present disclosure that there is a very large number ways that the modules and their various embodiments, disclosed herein, can be combined to produce accumulators of varying types. The method and the apparatus of each of modules, including the various particular embodiments thereof, have particular advantages and disadvantages associated therewith depending on the desired objectives for accumulator. It is important to state that anything disclosed herein is intended to be used individually or in combination with anything else disclosed herein to produce an accumulator having any desired combination of things, even though a particular desired combination is not expressly described herein. This statement provides notice that any and all combinations of anything disclosed herein is anticipated by and implicitly disclosed by the present applicants. Given number of ideas and amount of information disclosed herein, it would simply not be practical to provide such an exhausting and endless disclosure to explicitly disclose each and every combination of the ideas disclosed herein. Such combinations include for example and without limitation, combinations of the method and the apparatus of each of modules, including the various particular embodiments thereof, disclosed herein.

In each of the embodiments disclosed herein, the bales are preferably received directly from the baler 101 in a bale receiving direction 222 opposite to the accumulator and baler traveling direction 221. Alternatively, the bales may be picked up off the ground after the bales have been deposited on the ground by the bale 10r. Further, the bales may be received from the baler 101 or picked up off the ground along any axis, and not necessarily limited to an axis corresponding to an axis formed by the direction of travel of the accumulator.

Each of the modules disclosed herein is intended to be attachable to and detachable from the agricultural bale accumulator independently of any other module on the agricultural bale accumulator. A modular assembly of the accumulator permits a manufacturer to produce a common accumulator platform adaptable to receive the modules order by a customer to meet the customers particular needs without overburdening the manufacturer. Moreover, such a modular assembly also permits a customer to upgrade the accumulator's capabilities as the customer's needs change over time. However, a modular assembly is not intended to be limiting. An accumulator may be made having one or more of the modules where in the modules are integrated and not intended to be upgraded, mixed and matched, custom ordered, or the like. Business decisions will determine whether the modules will be attachable to and detachable from the accumulator or integrated with the accumulator.

Therefore, while the present invention has been described with reference to various illustrative embodiments thereof, the present invention is not intended to be limited to these specific embodiments. Those skilled in the art will recognize that variations and modifications can be made without departing from the spirit and scope of the invention as set forth in the appended claims.

Moreover, in the specification and in the claims, the terms "comprises", "comprising", "includes", "including", "including, at least" or any other variation thereof, are intended to be interpreted as a non-exclusive inclusion of elements listed after such a term, such that a description

or a claim of a method or apparatus using such a term that recites a number of elements after the term not only includes solely those elements listed, but also may include other elements not listed. Hence, such terms shall be interpreted as open ended inclusions.

XV. Industrial Application

The accumulator described herein is particularly suitable for, but not limited to, use with the following equipment made by the following manufacturers: Agco: 4910 large baler and 4755 mid-size baler, GPS receiver system: FIELDSTAR (TM); Case IH: 8575 mid-size baler and 8500 large baler; GPS receiver system: Advance Farming Systems (AFS) (TM); John Deere: Baler: 100 Big Square Baler. GPS receiver system: GREENSTAR (TM); New Holland: Baler: 590 and 595.

We claim: